IMP. BUREAU ENTOM.
Recd. 10 MAR 1913
Answd.

State of Connecticut

REPORT

OF

The Connecticut Agricultural Experiment Station

EIGHTH REPORT OF THE STATE ENTOMOLOGIST, 1908

W. E. BRITTON, PH.D.

BEING PART XI OF THE BIENNIAL REPORT OF 1907-1908

EIGHTH REPORT

OF THE

STATE ENTOMOLOGIST

OF

CONNECTICUT

FOR THE YEAR 1908

BY

W. E. BRITTON, PH.D.

State Entomologist

New Haven, Conn.

1909

CONTENTS.

	PAGE.
Letter of Submittal	763
Report of Receipts and Expenditures	763
Office Force and Field Organization	765
Lectures, Correspondence, Inspection Work	765
Collection and Equipment	766
Publications	767
Chief Lines of Work	768
Entomological Features of 1908	768
Nursery Inspection	770
List of Nursery Firms	771
Gypsy Moth Suppression	772
Scouting for Egg-masses	773
Scouting in other parts of the state	774
Funds	776
Infested Localities near Connecticut	776
Present Condition of Infested Area at Stonington	776
Summary	777
Canker Worms	777
Introduction	777
Early Records	777
History in Connecticut	779
Life History	780
Description	782
Number of Eggs Laid	784
Natural Enemies	786
Remedies	786
How to Band the Trees	792
Cost of Banding Trees	794
Summary	794
Further Tests of Gases to Destroy San José Scale	796
Carbon Disulphide	797
Carbon Tetrachloride	798
Acetylene	798
Mosquito Work in 1908	800
State Rifle Range, East Haven	800
Beaver Swamp Region	802
Breeding-Places Around Stamford	804
Insects Attacking Cucurbitaceous Plants	805
Squash Borer	806
Striped Cucumber Beetle	807

PAGE.

Insects, etc.:
Southern Corn-Root Worm or Twelve-Spotted Cucumber Beetle. 809
Squash Lady-Beetle 810
Squash Bug 811
Melon Aphis or Plant Louse 813
Squash Aphis 814
Greenhouse White Fly 815
Elm Leaf Beetle 815
History and Distribution 816
Life History and Habits 817
Description 818
Effect upon the Trees 819
Food Plants 820
Number of Generations 820
Natural Enemies 821
Remedies 823
Outfit for Spraying Elm Trees 825
Summary 827
Green Clover Worm a Pest of Beans 828
Identity Established 828
Injury to Beans and other Food Plants 829
Life History 829
Description 830
Remedies 832
Treatment of Cabbage Plants to Prevent Injury by Cabbage Maggot 832
Mount Carmel Experiments 832
Branford Experiments 835
Value of Tarred Paper Disks 835
Making the Paper Disks 836
Experiences with Home-Made Soluble Oils and some other Spray Mixtures 837
Other Oils Tried 840
New Prepared Lime and Sulphur Washes 840
Conclusions 841
Insect Notes 842

ILLUSTRATIONS.

Figure 9 is from a drawing by W. E. Britton; 10, 19 and 20 are from drawings by B. H. Walden; 11 to 18 are from the Bureau of Entomology, U. S. Department of Agriculture.

Plates XLII and XLIII are from photographs by G. H. Hollister; LI, LIV a and b, LV a and e, and LVII b, by W. E. Britton; LVI after Prof. J. B. Smith, N. J. Agricultural Experiment Station; all others from photographs by B. H. Walden.

PART XI.

EIGHTH REPORT

OF THE

STATE ENTOMOLOGIST OF CONNECTICUT

To the Director and Board of Control of the Connecticut Agricultural Experiment Station:

I hereby transmit my eighth annual report as state entomologist of Connecticut in compliance with the statutes. The financial statements cover the two fiscal years ending September 30th, 1908, but other administrative details are for the calendar years of 1907 and 1908.

Respectfully submitted,

W. E. BRITTON,
State Entomologist.

REPORT OF THE RECEIPTS AND EXPENDITURES OF THE STATE ENTOMOLOGIST FROM OCTOBER 1ST, 1906, TO SEPTEMBER 30TH, 1908.

FOR THE YEAR ENDING SEPTEMBER 30TH, 1907.

Insect Pest Account.

RECEIPTS.

From E. H. Jenkins, Treasurer	$3,750.00
Account of 1906, balance	18.53
Conn. Board of Agriculture, for gypsy moth work	100.00
	$3,868.53

EXPENDITURES.

For field, office and laboratory assistance	$1,330.85	
Printing and illustrations	83.35	
Postage	56.40	

Stationery	$1.25	
Telegraph and telephone	5.65	
Express, freight and cartage	20.75	
Library	104.84	
Laboratory apparatus and supplies	86.06	
Office supplies	28.58	
Traveling expenses	268.66	
Gypsy moth control work	1,604.91	
Balance, cash on hand	277.23	
		$3,868.53

Gypsy Moth Control Account.

RECEIPTS.

From E. H. Jenkins, Treasurer	$2,500.00

EXPENDITURES.

For salary of superintendent, and labor	$2.210.43	
Printing	12.50	
Tools and supplies	232.54	
Express, freight and cartage	11.95	
Traveling expenses	29.66	
Balance, cash on hand	2.92	
		$2,500.00

FOR THE YEAR ENDING SEPTEMBER 30TH, 1908.

Insect Pest Account.

RECEIPTS.

From E. H. Jenkins, Treasurer	$3,000.00
" " " (expenses transferred to station account)	5.25
Account of 1907, balance	277.23
Sale of cabbages (experimental plot)	5.00
Sale of postage stamps	.19
	$3,287.67

EXPENDITURES.

For field, office and laboratory assistance	$1,738.18	
Printing and illustrations	162.03	
Postage	6.64	
Stationery	7.70	
Telephone and telegraph	2.30	
Express, freight and cartage	16.25	
Library	155.86	
Laboratory apparatus and supplies	76.94	
Office supplies	23.80	
Traveling expenses	318.50	
Balance cash on hand	779.47	
		$3,287.67

Gypsy Moth Control Account.

RECEIPTS.

From E. H. Jenkins, Treasurer	$2,500.00
Account of 1907, balance	2.92
	$2,502.92

EXPENDITURES.

For salary of superintendent, and labor	$2,105.61	
Printing	2.75	
Tools and supplies	203.71	
Rental	56.00	
Express, freight and cartage	5.37	
Traveling expenses	126.26	
Balance, cash on hand	3.22	
		$2,502.92

Memorandum:—This account of the state entomologist has been duly audited by the State Auditors of Public Accounts.

Office Force and Field Organization.

Throughout the two years covered by this report the state entomologist has been assisted by Mr. B. H. Walden as general assistant, who has had charge of the office in the absence of the entomologist; by Mr. G. H. Hollister, who has had charge of the field work of suppressing the gypsy moth; by Miss E. B. Whittlesey, who has been employed as stenographer and clerical assistant in the office. Messrs. Walden and Hollister have each year helped in the inspection of nurseries, and Mr. S. P. Hollister also assisted in this work for a few days during 1908. Miss Beatrice Ross was employed for two weeks on extra clerical work in January, 1908. All of these assistants have served faithfully and willingly, and they have contributed in no small measure to the success of the work of this office.

In the gypsy moth work at Stonington, Mr. Hollister has employed chiefly local help, and has been given full authority to hire or discharge anyone according to his judgment. About twenty men were kept at work cutting brush and turning bands during June and July, 1907, but in 1908 most of the brush had been cut and less than ten men were employed.

Lectures, Correspondence and Inspection Work.

During the calendar year of 1908, thirteen lectures have been given before granges and agricultural and scientific meetings, and

1,236 letters and 51 packages sent out on business pertaining to the work of the office. The force has also made forty-two inspections of nurseries, and forty-two certificates have been granted. Examinations have been made of forty orchards, gardens, etc., and one hundred and forty-seven samples of insects have been received for identification.

Collection and Equipment.

The collection of insects has been considerably increased during the past two years by exchanges and material collected within the state. Mention should here be made and thanks expressed to Mr. Charles R. Ely of Washington, D. C., who has enriched our collection with material collected at East River, Conn., supplying us with over sixty species, many of which were not in our collection, while some of them had not been recorded from the state. Also to Mr. F. A. Merrick of New Brighton, Pa., who supplied about one hundred and forty-seven species, one hundred and fifteen of which were new to the collection; Mr. C. A. Frost, of South Framingham, Mass., forty-eight species, forty-two of which were new to the collection; A. C. Samson of Boston, Mass., thirty-five species, fourteen new to the collection. Exchanges were effected with these persons, but in each case the station collection benefited by receiving many more species and specimens than we were able to give in return, the collectors expressing a desire to place their duplicates where they would be of use even though they did not receive specimen for specimen in return. This attitude is or should be the proper one for the scientist. Last but not least, thanks are due to Professor H. W. Foote of Yale University, who has for three seasons collected moths during July and August at Pemaquid Point, Me., and given them to the station collection.

The Lepidoptera (butterflies and moths) have now all been transferred to larger Schmitt boxes (11½ x 16 in. inside), which were made to order of the proper size to fill the space occupied by two ordinary boxes with the partition between them. Fifty-six of these boxes are now filled with butterflies and moths. Fourteen metal cases and several wooden cases are used to hold the collection, which now contains about 4,000 named species and over 26,000 specimens.

A colony of bees in a Cary hive has been procured for study; these swarmed in June, and the swarm was placed in a Danzenbaker hive, so there are now two hives. A Miller observation hive has also been purchased for the laboratory and is of much interest to visitors.

PUBLICATIONS FROM THE ENTOMOLOGICAL DEPARTMENT 1907-1908.

Sixth Report of the State Entomologist (Part IV of the Station Report for 1906); 88 pages, 1 map, 13 text figures, XVI plates. 9,000 copies, distributed in March, 1907.

Seventh Report of the State Entomologist (Part V of the Station Biennial Report for 1907-1908); 73 pages, 6 text figures, XVI plates. 9,000 copies, distributed in March, 1908.

Bulletin 155. The Elm Leaf Beetle, by W. E. Britton. 15 pages, 6 figures. 10,000 copies. May, 1907.

Bulletin of Immediate Information No. 5. The Gypsy Moth Situation and the New Law. 4 pages. 1,000 copies. June, 1907.

Bulletin 157. Lead Arsenate and Paris Green. Part II. Directions for Their Use as Insecticides, by W. E. Britton. 12-13 pages. 10,000 copies. September, 1907.

Bulletin 159. Spray Calendar. Insect portion by W. E. Britton. 12,000 copies. January, 1908.

Occurrence of the Gypsy Moth in Connecticut, by W. E. Britton. A short paper read at the meeting of the Association of Economic Entomologists at New York, December, 1906. Published in Bulletin 67, Bureau of Entomology, U. S. Dept. of Agr., p. 22. 4 pages. 1907.

The Gypsy Moth in Connecticut, by W. E. Britton. Report of Connecticut Board of Agriculture for 1906. 13 pages, 5 text figures. 1907.

Some Connecticut Problems, by W. E. Britton. Proceedings New York State Fruit Growers' Association for 1907, p. 151. 1907.

Report of Committee on Injurious Insects, by W. E. Britton, Chairman. Report Connecticut Pomological Society, Vol. IX, p. 28. 1907.

Do. Vol. X, p. 23. 1908.

Some New or Little-Known Aleyrodidæ from Connecticut, by W. E. Britton. III. *Entomological News*, Vol. XVIII, p. 337. 6 pages, 2 plates. October, 1907.

Tests of Various Gases for Fumigating Nursery Trees, by W. E. Britton. *Journal of Economic Entomology*, Vol. I, p. 110. 3 pages. April, 1908.

Postal Card Bulletin on Canker Worms, by W. E. Britton. 5,000 copies. October, 1908.

Notes from Connecticut, by W. E. Britton. *Journal of Economic Entomology*, Vol. I, p. 313. October, 1908.

Notes on a New Sawfly (*Pamphilius persicum* MacG.) Attacking the Peach, by B. H. Walden. Bulletin 67, Bureau of Entomology, U. S. Dept. of Agr., p. 85. 2 pages, 1 plate. 1907.

The Peach Sawfly; A Correction, by B. H. Walden. *Journal of Economic Entomology*, Vol. I, p. 160. April, 1908.

Chief Lines of Work.

The general work of suppressing the gypsy moth, inspecting the nurseries, identifying insects and correspondence has consumed the usual amount of time and effort. Each of these is mentioned on another page of this report.

A study has been made of the insects attacking truck crops, and in this work tests have been made at Mount Carmel of various substances to prevent injury from the cabbage maggot. The squash borer has also been the object of similar tests.

Tests of various substances for fumigating to destroy San José scale on nursery stock have been continued, and some attention has been given to the question of preparing "soluble oils" for killing the San José scale. Further observations regarding the life history of the peach sawfly have been made by Mr. Walden, and several localities have been examined for mosquito-breeding areas.

Much time has been devoted to the insect collection and to the preparation of the papers on the Orthoptera and Hymenoptera of Connecticut which are to be published by the State Geological and Natural History Survey. The manuscript of the Orthoptera has been completed and is now awaiting publication.

Entomological Features of 1908.

From year to year the careful observer notes changes as regards the prevalence or scarcity of various kinds of insects, especially those which are pests attacking cultivated crops. The fluctuation is great with some species, such as the spiny elm caterpillar, *Euvanessa antiopa* Linn., and the apple leaf miner, *Tischeria malifoliella* Clem., which were exceedingly abundant in 1906, but have hardly been noticed since then. They are present each year, but they attract attention only when they become abundant. On the other hand, certain insects like the potato beetle, *Leptinotarsa decemlineata* Say, the cabbage butterfly, *Pontia rapæ* Linn., and the important currant worm, *Pteronus ribesii* Scop., are so constant in their appearance and numbers that the grower expects to combat them year after year, and thus makes control operations a part of his regular work and plans for it accordingly.

The winter of 1907-1908 was rather severe, and as the preceding winter was also a severe one, the San José scale in many

cases was killed so that it has not spread as much as usual. The reason apparently must be due to climatic conditions rather than to any particular predaceous or parasitic enemies which are effecting its control. At least, no such enemies have been observed in Connecticut which have not been present for several years, and those have not seemed to be more abundant than usual. In some instances the pest has not made any appreciable spread in two years, and some persons believe that it is no longer to be feared as a dangerous enemy to orchards; but in other cases, especially in young orchards and in some nurseries, the San José scale has multiplied sufficiently to leave no doubt in the minds of the owners or of any observer that it still must be reckoned with as the chief insect enemy of orchards in Connecticut. There should be no "let-up" in the thoroughness or regularity of the remedial treatment.

Canker worms, as predicted, were more abundant than in 1907, and defoliated many apple orchards and shade trees. They will doubtless be even more abundant in 1909, and everyone who wishes to save the foliage of his trees should band them. A detailed account of the two species of canker worms will be found on page 777 of this report.

The elm leaf beetle was more abundant and caused more injury to shade trees throughout the state than for several years. The precipitation was below the normal, especially during June and July, and this, following a dry season in 1907, prevented the development of the white fungus that normally kills large numbers of pupæ and adults. Many of the beetles, though of course a small proportion, were killed by the spined soldier bug, *Podisus malculiventris* Say (=*spinosus* Dall.), which was more than usually abundant. The elm leaf beetle may be expected to do fully as much damage in 1909, and all trees which were defoliated during the past season should be sprayed with poison next summer.

In the vicinity of New Haven beans were attacked and injured by a green striped caterpillar, which on rearing the adults proved to be the green clover worm, *Plathypena scabra,* which has not before been reported on beans in Connecticut. An article on page 828 gives an account of this insect.

Tussock moths of all kinds were abundant, but late in August and through September many dead caterpillars were found on

the trunks of trees, having been killed by a fungus, the prevalence of which has undoubtedly been an important check to these insects and will render them less common next season.

Plant lice were abundant and checked the growth of young apple trees in orchards and nurseries.

Mites (probably *Tetranychus bicolor* Banks) were abundant everywhere on chestnut, and the same or an allied species was also on oak, causing the leaves to turn brown late in the summer. The pear leaf mite, *Eriophyes pyri* Nal., was prevalent, and specimens were received from several localities, where it formed reddish galls upon the leaves.

Nursery Inspection.

The annual inspection of nurseries, as provided for by the General Statutes (Sections 4388-4389), was begun this year on August 27th, or about a week earlier than usual. Fair weather prevailed and enabled us to nearly complete the work by the middle of October, though not wholly finished until November.

The condition of the nurseries of the state was on the whole found to be somewhat better than last year, but there is no decided change. Individual nurseries presented differences, some being better and some worse. In a region thoroughly infested with San José scale, where nurserymen have carefully sprayed their growing stock with soluble or miscible oil, one part in not more than fifteen parts of water, the plantations have been much improved, some being comparatively free from scale. On the other hand, where this treatment was done indifferently or carelessly, or neglected altogether, the stock was in bad condition and much of it was destroyed.

The inspections were made by Messrs. Britton, Walden, G. H. Hollister and S. P. Hollister, the first three being employed throughout the work and the last helping only about ten days in the large nurseries.

Two nurseries were inspected during the spring and forty in the fall, making forty-two inspections. Forty-two certificates were granted. The death of one nurseryman and the appearance of five new firms changes slightly the list, which follows:

LIST OF NURSERY FIRMS IN CONNECTICUT RECEIVING CERTIFICATES IN 1908.

Name of Firm.	Location.	Inspection finished.	Certificate number.
Atwater, C. W.	Collinsville	Sept. 28,	297
Barnes Bros. Nursery Co.	Yalesville	Sept. 26,	294
Beattie, Wm. H.	New Haven	Sept. 28,	295
Bowditch, J. H.	Pomfret Center	Sept. 3,	286
Brainard, D. Wm. & C. F.	Thompsonville	Oct. 19,	313
Burroughs, Thos. E.	Deep River	Oct. 12,	309
Burr & Co., C. R.	Manchester	Sept. 22,	291
Comstock & Lyon	Norwalk	Oct. 27,	317
Conine Nursery Co., The F. E.	Stratford	Sept. 29,	296
Conn. Agricultural College	Storrs	Oct. 13,	310
Conn. Agr. Experiment Station, Forest Nursery (A. F. Hawes, State Forester, New Haven)	Rainbow (Windsor)	Oct. 5,	304
Conway, W. B.	New Haven	Oct. 24,	315
Dehn & Bertolf	Greenwich	Sept. 23,	292
Dwyer, John E.	Manchester	Nov. 12,	321
East Rock Park Nursery (G. X. Amrhyn, Supt.)	New Haven	Sept. 2,	285
Elizabeth Park Nursery (G. A. Parker, Supt.)	Hartford	Nov. 5,	320
Elm City Nursery Co,	New Haven	Sept. 5,	287
Gardner's Nurseries	Cromwell	Oct. 29,	318
Gurney & Co., H. H.	New Canaan	Sept. 22,	290
Hale, J. H.	So. Glastonbury	Oct. 12,	308
Holcomb, Irving	Granby	Sept. 18,	288
Houston & Sons, J. R.	Mansfield Depot	Oct. 9,	305
Hoyt's Sons Co., Stephen	New Canaan	Sept. 22,	289
Hubbard & Co., Paul M.	Bristol	Oct. 5,	301
Hunt & Co., W. W.	Hartford	Oct. 1,	298
Kellner, H. H.	Danbury (2)	Oct. 21,	314
Kelsey & Sons, David S.	West Hartford	Sept. 29,	299
Keney Park Nursery (G. A. Parker, Supt.)	Hartford	Nov. 5,	319
Malone, Geo. W.	Highwood	Oct. 26,	316
Phelps, J. Wesson	Bolton (2)	Oct. 9,	306
Pierson, A. N.	Cromwell	Sept. 1,	284
Platt Co., The Frank S.	New Haven	Oct. 13,	311
Purinton, C. O.	Hartford	Dec. 24,	323
Ryther, O. E.	Norwich	Oct. 16,	312
Schoonman, W. J.	Danielson	Dec. 7,	322
Scott, J. W.	Hartford	Oct. 10,	307
Sierman, C. H.	Hartford	Oct. 2,	300
Vidbourne & Co., J.	Hartford	Sept. 25,	293
Woodruff, C. V.	Orange	Oct. 5,	302
Woodruff & Sons, S. D.	Orange	Oct. 5,	303

ACCOUNT OF PROGRESS IN SUPPRESSING THE GYPSY MOTH IN CONNECTICUT.

For an account of the discovery of the gypsy moth in Connecticut at Stonington and the attempts to control this pest the reader is referred to the three preceding reports of this station (1905, p. 246; 1906, p. 235, and 1907-08, p. 300). Only a record of progress is here given.

Throughout the year Mr. G. H. Hollister has been the superintendent in immediate charge of the work. Commencing on November 18th, 1907, Mr. Hollister employed about five men for most of the time during the winter, cutting and burning brush, pruning trees and scouting for egg-masses. About ten rods of stone wall had to be overhauled and relaid, a number of wood and rubbish piles had to be looked over, and, of course, the trees examined.

In May the trees were banded, about 14,000 in all, including all those within the boundaries of the infested area and many outside, especially to the north. In doing this we used one and one-half bales of eight-ounce burlap cut into eight-inch strips.

During 1908 no indications were found that the pest had spread to the region outside of the area known to be infested the previous year, but on the contrary, over a portion of this area where caterpillars were taken in 1907 none were found in 1908. The size of the area actually known to be infested has therefore been decreased by the suppression work. The Stanton place was perhaps the worst center of infestation for the season, but during June about two hundred and seventy-five caterpillars were discovered on some low rosebushes in the loose stones beside the wall near the Ross estate. A careful search was here made and all caterpillars that could be found were destroyed. The spot was then oiled and burned.

On July 2d two of the men discovered some caterpillars on weeds and brush in and around the chicken yard of Mr. Kellar's residence on Bay View Avenue. In making a systematic hunt, about one hundred and twenty-five in all were found, and the weeds and useless bushes were immediately cut and burned and the stone wall burned out with a torch of flame. Fifty gallons of oil was used in burning out walls, stoneheaps and dumps. A few caterpillars were found each day at Walnut Grove, but not in important numbers. The seriousness of this infestation lies in

the character of the region, a dense grove of tall oak, hickory and other trees, which grow among rocks and boulders, making it difficult to control the pest should it once gain a foothold. Much searching was done here in addition to the regular work of examining bands. The men climbed the trees perhaps a dozen times during the summer, and in this way many of the caterpillars were found and destroyed.

All of the coniferous trees and part of the apple trees and ornamental shrubbery on the Stanton place, some shrubs of Japanese quince at Mr. Darrell's, the bushes near the water at Mr. Simmons', small fruit trees and Boston ivy at Mr. Koelb's and the quince bushes at Mrs. Thatcher's were sprayed with lead arsenate (three to five pounds in fifty gallons of water), thirty pounds of the poison being used. Mr. Hollister observed dead and dying caterpillars a few days after the applications. "Tree Tanglefoot" was applied to the trunks of the evergreens and apple trees adjoining in order to prevent the caterpillars from crawling up or down, about twelve pounds of this material being used.

Scouting for Egg-Masses.

All trees, and many of the fences, stone walls and buildings within the infested area were examined for egg-masses during the winter. A careful search was made around the places where caterpillars were taken during the preceding summer, and seventy-three egg-masses were found and destroyed by soaking them with creosote. Most of the scouting was done by Messrs. Hollister, Norman and McDermott, and before April 1st this was finished and Hollister and Norman had worked about two weeks around Hartford. Mr. Hollister had also visited several towns in the northeastern part of the state. According to agreement, Mr. Rogers furnished help to scout the infested region after it had been examined by our men, but on account of the great amount of work done in Massachusetts, Maine and New Hampshire, he could send only one man, Mr. G. D. Whitehead, who worked in Connecticut during the month of April, first going over the Stonington infested territory with Mr. Hollister (finding nine egg-masses), and then with him scouting the road to New London and then from New Haven to Hartford.

The scouting done outside of Stonington may perhaps be best described by the following notes by Mr. Hollister.

SCOUTING FOR THE GYPSY MOTH IN OTHER PARTS OF THE STATE.

Hartford Region—"An egg-mass of the gypsy moth having been found in Springfield, Mass., and Hartford being on the same route from Boston to New Haven and New York, it was thought advisable to spend some time scouting around the garages in that city, and then to scout the main highways leading to Springfield on each side of the Connecticut River.

"Scouting was commenced about the 24th of February, 1908, and continued two weeks in this vicinity by Mr. E. W. Norman and myself.

"On the west side of the river the towns of Windsor, Windsor Locks and Suffield were visited, the scouting being done along the main highway and including the shade trees, the orchards bordering on the highway, freight yards and garages. In the villages several of the streets other than the main one were scouted. On this side of the river scouting was carried on as far north as the road leading from Suffield to Thompsonville.

"East Hartford, South Windsor, East Windsor Hill, Warehouse Point, Enfield and Thompsonville were all visited, as well as all the territory between these villages along the main highway on the east side of the river. Considerable time was spent around the freight yard in East Hartford, as a great many of the cars pass through infested territory in Massachusetts.

"The scouts were on the lookout for any nests of the brown-tail moth as well as for those of the gypsy moth, but no evidences were found of either.

"It is estimated that a distance of one hundred and twenty-five miles was traversed.

Eastern Connecticut—"The latter part of March and first of April several of the larger towns were visited by the writer to look for evidences of the gypsy moth and brown-tail moth.

"Norwich, Plainfield, Danielson, Putnam, Grosvernordale, East Thompson, Willimantic and Middletown were visited. In these places, garages, freight yards, and some of the shade and fruit trees were examined.

"As Putnam is the largest town in the northeastern part of the state nearest the Massachusetts infestations, considerable time was spent there scouting the shade trees and orchards bordering on the highways. Quite a little time was occupied in scouting

the village of East Thompson. At the other places above mentioned only the stations, freight yards, garages and the trees near the same were scouted. Not a sign of either the gypsy or brown-tail moth was found.

"A distance of forty miles was covered.

"Mr. G. D. Whitehead, a government scout, was sent to Stonington April 1st, and scouted in various parts of the state until May 2d. He and the writer scouted the main highway to Mystic, Noank and Midway, spending some time at the freight yard in the latter place.

"Three days were spent in New London, where the trees were examined on Main, Bank and Broad streets and on Montauk, Pequot and Ocean avenues. Several garages and the freight yards were scouted, also some of the trees along the banks of the Thames River near where automobiles attending the boat-races were stationed. The trees in Williams Park and around Williams Memorial Institute were scouted.

"About thirty-five or forty miles were traversed, and no evidence of moths were found.

New Haven to Hartford—"Mr. Whitehead and the writer left for New Haven the 23d of April, where they began scouting for the gypsy moth. Twenty-six garages were visited and the trees in the vicinity of the same were inspected. The freight yards were also examined.

"Scouting was then taken up along the main automobile route to Hartford, passing through the towns of North Haven, Wallingford, Yalesville, Meriden, Berlin Junction, New Britain and Newington to Hartford. Here, as on the other trips, the shade trees and orchards bordering on the highway were scouted, also the garages in Wallingford, Meriden and New Britain.

"New Britain Avenue and Farmington Avenue in Hartford were both scouted, as automobiles follow both routes into the city.

"No evidences of the gypsy moth or brown-tail moth were found after traversing a distance estimated at eighty miles.

"About a week was spent on this route, and then May 2d was spent scouting about in the village of Pomfret. This included the street trees and also the shade trees near Pomfret School. The street leading from the station past the school to the Putnam

road was scouted, also another leading from the station out to some private estates a mile away.

"Here, as at the other places, no moths were found."

Funds.

The State Board of Control has seen fit to grant the funds necessary to carry on the work, $2,500 having been used during the fiscal year ending September 30th, 1908. It is hoped that the legislature will renew the provisions of the act, or at least provide funds to continue the suppression work until the pest has been exterminated from the state.

Infested Localities Near Connecticut.

During the year the Massachusetts authorities sent scouts to examine the main thoroughfares in various portions of that state, and this resulted in finding gypsy moth infestations in several new places, including Springfield, Greenfield, Palmer and Warren. Springfield being only a few miles from the Connecticut border, the fact that egg-masses were found there naturally caused some anxiety lest the whole region be infested, but a careful search of both sides of the river from the state line southward did not result in finding any signs of the pest.

The edge of the general infestation in Eastern Massachusetts, however, has been extended from year to year by the natural spread of the insect, aided by the usual methods of conveyance and traffic, until it now reaches well towards the boundary of Connecticut.

Present Condition of the Infested Area at Stonington.

The conditions are now more favorable for the extermination of the gypsy moth than they have been at any time since this pest was discovered to be in the state. The territory has been well cleaned up by cutting brush and disposing of rubbish, by pruning and scraping trees and cutting worthless ones, and filling and tinning cavities. The actual size of the infested area has been considerably reduced during the year, so that it will not be necessary to band as many trees next year. This will require a smaller force of help, and of course will be less expensive.

GENERAL SUMMARY.

	1906	1907	1908
Egg-masses laid during preceding year, number destroyed	29	118	73
Egg-masses laid during same year, number destroyed	47	70	3
Caterpillars, number destroyed	10,000	2,936	2,560
Pupæ, number destroyed	47	200	44
Trees banded with burlap, number of	1,300	13,000	14,000
Funds expended by the state	$1,500	$4,550	$2,500
" " " " government	....	272	77

CANKER WORMS.

Spring Canker Worm,
Paleacrita vernata Peck.
Fall Canker Worm,
Alsophila pometaria Harris.

INTRODUCTION.

The name canker worm is applied to two species of insects similar in habits and appearance and closely related, which are moths of the family Geometridæ, the larvæ of which are known as "loopers" or "measuring worms." Canker worms are of economic importance because they devour the foliage of various trees and plants, often causing considerable injury. They are general feeders and therefore attack a large number of different kinds of trees, but seem to have a preference for the foliage of apple, elm, chestnut, pear, oak, hickory, box-elder and maple, in about the order named.

EARLY RECORDS.

The spring canker worm was first described by Professor W. D. Peck in 1795. The difference between the sexes was known at this time, but there was supposed to be only one species, evidently *vernata*. The following is a quotation from Peck's original account as published by Ridley.*

FIG. 9. Canker Worms on apple leaf. Reduced.

* Seventh Annual Report on the Noxious, Beneficial and Other Insects of Missouri, 1874, p. 89.

"These insects (the Canker-worm) appear in the spring earlier than any other of the moth tribe—about the middle of March. Their rise, however, from the earth will be delayed or hastened according to the temperature of the atmosphere and state of the soil. They are found under a double form, the males being furnished with, and the females being destitute of, wings. This circumstance necessitates the females to ascend the tree by its trunk in order to deposit their eggs upon the branches. The males by their wings resort to them, and are found in the evenings hovering around the trees. In three or four days after they begin to rise, they are found *sub-copula*. This office is performed in eleven or twelve days after their first appearance. The males die and disappear. In thirteen days the females deposit their eggs. These they place in the crannies of the bark in the forks of small branches; and where there are spots of moss upon the smaller limbs, they seem most fond of insinuating themselves into the cavities between its leaves. For this purpose the females are furnished with a tube through which the egg is passed, with which she investigates the apertures in the bark or moss and ascertains their depth. * * * Each female lays at a medium an hundred eggs. The ultimate purpose of their being thus performed, they die."

Dr. T. W. Harris of Cambridge, Mass., made observations on canker worms of that section, which he supposed to be Peck's species, though somewhat larger and differently marked. He states:* "Perhaps they constitute a different species from that of the true canker worm moth. Should this be the case, the latter may be called *Anisopteryx pometaria*."

The spring canker worm was the common species in the Mississippi River valley, while the fall species is more common in New England, though both species are found throughout the eastern portion of the United States. Dr. Charles V. Riley was probably the first to accurately describe† and figure the characters of both kinds of canker worms, thus proving them to be distinct species.

---

* Insects Injurious to Vegetation, 1841, p. 333. Flint Edition, 1863, p. 402.
† Seventh Annual Report on the Noxious, Beneficial and Other Insects of Missouri, 1874, p. 80.

History in Connecticut.

Mr. Henry T. Blake of New Haven states* that "in 1839, by vote of the Common Council, one hundred and fifty maples and elms, principally maples, were set out on the public square. The maples were preferred at that time on account of the liability of elms to be ravaged by the measuring worm, or canker worm, as it was generally called. This worm has appeared at intervals since 1750, but the first serious experience of them within the present century occurred in 1838. Other visitations followed at frequent intervals down to 1850 and later, though in a modified degree. Prior to 1846 for several years before the middle of June the trees on the Green were stripped as bare as in the depths of winter. The fence, which was of wood, painted white, was so covered with worms as to appear entirely black. The walks were literally carpeted with them, and the air was full of their squirming forms descending from the barren branches. Many schemes were proposed for their extermination, but none were successful until the plan was adopted of surrounding the trunk of every tree in the fall of the year with large tin troughs filled with oil. This device was used quite generally, but the troughs were expensive and the oil was blown by the wind over the sidewalks and the clothes of passers-by. A smaller trough was then used, made of sheet lead, and these were placed upon the elms almost universally throughout the city, being kept in order and supplied with oil by annual contract. These remedies, continuously applied for several years, greatly diminished the pest, and of late the last of the lead troughs have disappeared. A band of cloth or paper coated with tar or printers' ink is now regarded as a sufficient protection."

According to Dr. Joseph Barratt, canker worms had disappeared in 1846,† and we have the statement of Mr. Robinson that they were again troublesome in 1866.‡ From what we know of the periodical occurrence of this pest, it is quite probable that an outbreak intervened, though we do not have a record of it. In 1884, Mr. P. M. Augur, then pomologist of

* Chronicles of New Haven Green, 1898, p. 30.
† Transactions Conn. Agr. Society for 1854, p. 120.
‡ Report Conn. Board of Agriculture for 1866, p. 81.

the Board of Agriculture, reported* that canker worms were abundant in some localities during the season and caused considerable damage.

Again in 1896, canker worms were abundant in the southern part of the state, and the writer published a short article† giving a brief description of the two species and recommending treatment. The fall canker worm was the more prevalent, and was responsible for most of the injury about the station grounds, though the spring species was present in apple orchards of the state.

From 1896, canker worms were present and caused damage to trees until 1900, when they became scarce at the station, so that it was difficult to find specimens. Their absence continued until the autumn of 1907, when adult males were noticed to be quite numerous, and early in the summer of 1908 orchard and shade trees in the southern part of the state were ravaged. During the season this office received four samples of canker worms and twenty-three letters regarding their work. The elm trees of New Haven were attacked and the leaves generally eaten, but most people attributed the injury wholly to the elm leaf beetle, which was also present in serious numbers. Canker worms even attacked privet hedges in some localities and defoliated portions of them. Though none of the trees on the station grounds were sprayed, the damage was sufficient to warrant the expense of banding the trees, and this was done in October.

A postal card bulletin was issued by this station, about October 1st, calling attention to the prevalence and injury of the canker worm and giving information about applying the sticky bands.

Life History.

The adults of the fall species appear during the warm days of November and December, often occurring in great numbers on foggy days during a thaw after the ground has been frozen. In 1908, the first females were observed around the bands October 28th, and from that time on they increased in abundance, being more in evidence than the males up to November 20th, when the males were apparently much in preponderance. Many eggs were

* Report Conn. Board of Agriculture for 1884, p. 290.
† Report Conn. Agr. Expt. Station for 1896, p. 234.

laid on the trees before the middle of November, and only a few males could be found. The females of both species are without wings, and must necessarily crawl up the trunks of the trees to lay their eggs on the twigs. Males, on the other hand, are provided with wings, and fly short distances at night and even during dark cloudy days. Many of the adults, however, do not emerge until March, and this is especially the case when the ground freezes early in the fall and does not thaw out until late in the winter.

In Saybrook, where the elm trees were considerably damaged by canker worms in 1907, sticky bands were applied about March 1st, 1908, as it was supposed to be the spring species that caused the injury; but it was found later that the fall species was the more abundant and that enough eggs had already been laid before the application of the sticky bands so that the trees were quite badly eaten by canker worms.

The eggs, though deposited in late fall or in early spring, hatch in Connecticut during the last of April or the first few days of May.

The young larvæ are at first very small, and they soon begin to feed on the tender unfolding leaves. They eat holes entirely through the leaves, or in fact devour all of the green tissue, leaving nothing but the veins. Later, as the foliage becomes firmer and more leathery, they often leave the greater portion of the network, especially in case of the apple (shown on Plate XLV) which turns brown in June and looks as if a fire had gone through the orchard.

The caterpillars feed from four to five weeks, during which time they spin down on threads of silk when disturbed, and molt three times. They then go to the ground and transform to the pupa or chrysalid stage. By June 6th, 1908, all canker worms had gone into the ground to pupate. They then remain in the pupa stage until the late fall, when the adults of the fall canker worm begin to emerge in November, and during warm days for two months they may be seen clustering on the trunks of trees; but some do not appear until March and April, at the same time that the spring species comes forth. There is but one generation each year.

Canker worms are always rather local in their attacks, and the writer has often seen large orchards defoliated in certain localities,

while in adjoining towns no damage could be seen. During 1908, the most severe injury occurred near the coast, though the insect was present locally in the northern portions of the state.

Description.

Spring Canker Worm, *Paleacrita vernata* Peck.

Egg. Laid in irregular masses which, according to Quaintance,* contain from seventeen to one hundred and nineteen eggs, with an average of forty-seven. Usually in secreted places in the crevices of the bark. The shell is thin, delicate, and of a light brown color, but more or less iridescent. About 0.7 mm. in length, and two-thirds as broad as long. See Plate XLIV b.

Larva or *Caterpillar.* The larva or caterpillar is slender, about three-fourths of an inch long when full grown, and is longitudinally striped with fine pale lines. The general color is dark gray or brownish. The most distinguishing feature, however, is that *no pro-legs are borne on the eighth segment,* there being in all only two pairs of pro-legs. The head is distinctly mottled and spotted.

Pupa or *Chrysalis.* Pupa light brown, about 7 mm. in length, enclosed in a simple earthen cell lined with a few threads of silk. The cell can be easily broken. The pupa is somewhat pitted, the wing sheaths of the male extending to the sixth abdominal segment, while those of the female extend only to the rear edge of the fifth segment. The male pupa is tipped with a spine, which is generally simple. See Plate XLIX a.

Imago or *Adult Moth.*

Male. Wing expanse of from seven-eighths to one and one-fourth inches, antennæ with less than forty joints, the longest more than twice as long as wide. Palpi short, two-jointed. Wings brownish gray, semitransparent, the fore wings marked rather indistinctly with three dark lines. A short dark line also bisects the apical angle of the fore wing. There is no prominent white spot on the costal margin. The rear wings are somewhat lighter and are without markings. Shown on Plate XLVII a.

Female. Antennæ with thirty or more joints, the longest about three times as long as wide. Antennæ, legs and body pubescent,

* Bulletin 68, Bur. of Entomology, U. S. Dept. of Agriculture, p. 18.

usually with brown and white or gray scales. A black or dark brown stripe extends longitudinally along the back. Abdomen tapering and terminating in a two-jointed ovipositor, which can be exserted and is rather conspicuous. Wingless.

Fall Canker Worm, *Alsophila pometaria* Harris.

Egg. Shaped like a truncated cone, fastened endwise to the tree or object, with the thicker end outward and marked with a dark spot in the center and a dark circle near the margin. The eggs are deposited in rows, in compact clusters of between fifty and three hundred eggs each (averaging about one hundred), and are usually laid on the bark of the smaller branches, but may be found on the trunk, or even on fences or stones. When sticky bands are employed, the eggs are laid sometimes on the band itself or on the bark of the trunk just below the band. In color the eggs are brownish gray, but somewhat darker than those of the spring species. On hatching, the young larvæ emerge from the outer end of the eggs, leaving a round hole about the size of the circular ring. Egg-masses are shown on Plate XLIV.

Larva or Caterpillar. Pale olive green at first, with pale head; later a dark gray or brownish form is often found together with the light green caterpillars, both of which are similarly striped with whitish lines. Both forms emerge from the same mass of eggs. *A pair of pro-legs is borne on the eighth segment,* making in all three pairs of pro-legs. The head is dark and indistinctly spotted. About three-fourths or seven-eighths of an inch long when fully grown. Caterpillars are shown on various food plants on Plates XLV and XLVI.

Pupa or *Chrysalis.* Somewhat stouter or broader and darker brown than in the spring species. Male wing-sheaths reaching to the sixth abdominal segment. Apex more blunt than in *vernata,* and the spine decurved and *always forked.* About 7 mm. in length. Not pitted. Enclosed in a rather strong silken cocoon interwoven with particles of soil, making a cell that is not easily crushed. See Plate XLIX b.

Imago or *Adult Moth.*

Male. Wing expanse of from one to one and one-fourth inches. Brownish gray in color, with a slight purplish reflection. Antennæ with over fifty joints, the length of the longest being

less than twice the diameter. Palpal joints indistinguishable. The wings are firmer, less transparent and darker in color than in the spring species. The fore wings are crossed by two whitish bands, the distal one being offset inward on the front margin, where it forms a prominent spot known as the costal spot. This outer band continues, though less conspicuous, across the rear wings. The inner band is much less prominent, or obsolete, and does not appear on the rear wings. Males are shown on Plate XLVII b.

Female. Antennæ with over fifty joints, the longest about as broad as long, not pubescent. Body and legs uniform ash-gray in color, without markings. Wingless. Abdomen without visible ovipositor. A female and egg-mass are shown on Plate XLIV a.

Number of Eggs Laid by the Fall Canker Worm.

On an average the female lays about one hundred eggs, usually in a single cluster, though sometimes in two clusters or in small scattered lots. The following figures show the number of eggs in isolated clusters collected from trees from which actual counts were made:

140	41	68	115	100
215	130	41	109	97
47	146	99	59	61
36	95	97	57	57
258	130	64	52	194
94	51	122	110	96
105	89	58	101	55
87	100	87	59	76
86	55	141	108	115
43	38	71	111	69
59	75	78	140	59
72	80	193	124	109
122	111	91	96	54
55	148	54	93	77
209	56	62	143	50
204	72	100	102	88
58	57	47	131	43
41	110	54	106	59
129	77	128	123	108
40	85	113	113	189
2,100	1,746	1,768	2,052	1,756

The above numbers of eggs in one hundred egg-masses show an average of about ninety-four eggs to the cluster and vary from thirty-eight to two hundred and fifty-eight. The smallest egg-masses probably each represent one of two clusters of eggs laid by one insect, or possibly the female was devoured by a bird or some other natural enemy before she had finished depositing eggs.

Eggs laid by females in captivity show a larger number in each mass than those collected from trees. The following numbers of eggs were laid by females collected November 20th, 1908:

165	81	140	92	206
111	90	78	89	251
114	149	95	96	231
256	126	148	128	292
148	160	108	145	242
133	173	38	112	256
240	132	102	162	191
285	102	103	109	229
135	109	146	104	181
154	157	230	51	
68	207	111	130	
202	102	233	99	
147	104	191	128	
141	114	118	148	
2,299	1,806	1,841	1,593	2,079

Thus these sixty-five egg-masses laid in confinement show an average of one hundred and forty-eight eggs, the smallest containing thirty-eight and the largest two hundred and ninety-two, while those collected from the trees out-of-doors average ninety-four each. It is hard to account for this difference. Still more curious is the fact that the numbers given in the first four columns represent eggs laid by females taken *in coitu,* and average one hundred and thirty-four to the cluster, while those in the last column were laid by females collected at random on the trees. It is not known whether these were impregnated or not, but the large average of two hundred and thirty-one to the cluster is difficult to explain. From a lot containing forty-three females, two laid no eggs and five laid eggs in irregular masses. A lot of fifty-four females had forty-two that deposited a single egg-mass each, eleven that laid two egg-masses, and one that laid three egg-masses.

Natural Enemies.

Apparently canker worms are not as highly parasitized as some other species of injurious insects, and little space is given in literature to natural enemies. Dr. Riley mentions* a mite, *Nothrus ovivorus* Pack., which Professor A. S. Packard observed feeding upon the eggs; a four-winged fly of the genus *Microgaster,* which parasitizes the caterpillars; a species of *Platygaster* that is a parasite of canker worm eggs; two large ground beetles, *Calosoma scrutator* and *Calosoma calidum,* which devour the caterpillars, and the potter wasp, *Eumenes fraternus,* which provisions its cells with the caterpillars. Mr. Robert Brown of Yale University has reared a small hymenopterous parasite from the eggs of the fall canker worm in New Haven, but at the time of this writing could not furnish any specimens and the insect remains unidentified.

In the manuscript of the "Hymenoptera of Connecticut," by Mr. Henry L. Viereck, *Ichneumon utilis* Cress. is stated to be a parasite of canker worms.

Many birds feed upon canker worms, the most important being the chickadee, bluebird, shrike, robin, creeper, thrush, cuckoo, warblers and woodpeckers.

Remedies.

Early Recommendations.

As the sex-differences were early known, so were the habits. Remedial treatment was also advocated in the eighteenth century, according to Dr. Samuel Deane, who wrote as follows:†

"This worm is produced from the eggs of an earth-colored bug, which having continued under ground during winter, passes up on the bodies of apple trees early in the spring. They are hatched as early as the end of May, and are so voracious that in a few weeks they destroy all of the leaves of a tree, prevent its bearing for that year, and the next, and give it the appearance of its having been burnt. As the perspiration of trees is stopped by the loss of their leaves, they sicken and die, in a few years.

* Second Annual Report on the Noxious, Beneficial and Other Insects of Missouri, 1870, p. 102.

† The Newengland Farmer or Georgical Dictionary, 1797.

"The worms let themselves down by threads in quest of prey, like spiders; by means of which the wind blows them from tree to tree; so that in a close orchard not one tree will escape them. But trees which stand singly are seldomer infested with these insects. As they are the most pernicious kind of insects with which Newengland is now infested, if any person could invent some easy, cheap, and effectual method of subduing them, he would merit the thanks of the publick, and more especially of every owner of an orchard.

"Several methods have been tried, with some degree of success: 1. Tarring. A strip of canvas or linen is put round the body of a tree, before the ground is open in the spring, and well smeared with tar. The females, in attempting to pass over it, stick fast and perish. But unless tarring be renewed every day, it will become hard, and permit the insects to pass safely over it. And renewing the tar in season is too apt to be neglected, through hurry of business and forgetfulness. If birdlime were to be had, it might answer the purpose better, as its tenacity will continue for some time. 2. Some tie straw round the bodies of the trees. This serves to entangle and retard the insects, and prevents the ascent of many of them. But they are so amazingly prolifick, that if ever so few of them get up, a tree is greatly damaged, at least for an ensuing season or two.

"The pasturing of swine in an orchard, where it can conveniently be done, I suppose to be an excellent method. With their snouts and their feet, they will destroy many of the insects, before they come out of the ground, or while they are coming out. And I have never known any orchard, constantly used as a hog pasture, wholly destroyed, or even made wholly unfruitful by these worms. But this method cannot always be taken; and if it could, I do not suppose it would be quite effectual. When the trees are young, the swine will be apt to injure them by tearing the bark.

"There are several experiments I could wish to have tried for subduing these insects: Such as burning brimstone under the trees in a calm time;—or piling dry ashes, or dry loose sand, round the roots of trees in the spring;—or throwing powdered quicklime, or soot, over the trees when they are wet; or sprinkling them, about the beginning of June, with sea water, or water in

which wormwood, or walnut leaves, have been boiled;—or with an infusion of elder, from which I should entertain some hope of success. The liquid may be safely applied to all the parts of a tree by a large wooden syringe, or squirt.

"I should suppose that the best time for making trial of these methods would be soon after the worms are hatched; For at that stage of their existence they are tender, and the more easily killed. Sometimes a frost happening at this season has destroyed them. This I am told was the case in some places in the year 1794."

At a meeting of the Connecticut Board of Agriculture in 1866 the following statement was made by a Mr. Robinson:*

"The canker worm is also troublesome, and the farmers in my neighborhood have suffered much from its ravages. If you go out in March, about half an hour after sundown, you will see crowds of millers rising up from the ground. These crawl up the trees and deposit their eggs, from which the worm in June is hatched. Now, the best way to get rid of the future worm is to prevent the miller from ascending the tree. My trees are all guarded with a mixture composed of equal parts of tar and urine, put in a band around the tree. It is not necessary to put the tar upon cloth, because it does not hurt the tree to apply it directly, and if spread upon a cloth, the worms can crawl underneath it. This application must be renewed every day while the millers are ascending the tree. If an examination is made the morning after this application of tar and urine, the bark of the tree will be found to be coated white with millers."

In these early days it was not known that there are two distinct species of canker worm, though it was known that some of the adults appeared in fall and others in spring, as the following quotation shows:†

"Mr. David Lyman of Middlefield remarked that his section of the state was a good region for the finer qualities of apples. He had found his apples, too, to be a profitable crop. The canker worm had been his greatest pest. Against this worm he had used tar as an application which had to be repeated every evening for a long time, say forty times. The canker worm moth

* Report Conn. Board of Agriculture for 1866, p. 81.
† *Idem*, p. 84.

comes up out of the ground in the fall as well as winter. Mr. Lyman has found this out by observation. To more effectually defend his trees from the ravages of this pest, Mr. Lyman has used the so-called 'Tree-protector,' which is designed to prevent the progress of the insect up the tree. It was a little instrument like a tent, held away from the tree by a wire, having its outer edge like an umbrella, with smooth strips of isinglass projecting from the edge; the design of which was this, that if the insects could crawl to the edge they could get no further on account of the slippery foothold they would have. But the conclusion from the application of these tree-protectors was this, that they were good for nothing, and the canker worm ascended the tree just as well after their application as before. He had tried next the experiment of ploughing his orchards. This had the effect to diminish the number of worms during one season upon his apple trees in an old orchard where the experiment was tried. The ploughing ought to be followed by an application of bonedust."

Further recommendations were also made at this meeting:*

"Professor Brewer said that the Professor of Zoölogy in the Sheffield Scientific School had been investigating the subject of the different pests of our trees, and especially the history of the canker worm, as it appears upon the elm trees about New Haven. Whether this variety of the worm is the same as that infesting the apple tree, the Professor was not certain, but in this they are alike, they strip the tree of foliage. The variety of worm infesting our elm trees attains its growth between the first and seventh of June. It is a common thing to say that they leave about the tenth of June. When they have attained their growth upon the tree, they leave and go down into the ground to go through with their second stage of development there, and as has been said, they come out of the ground in the fall. Three-fourths of our people believe that if they attempt to protect their trees against the ravages of this worm, that it is sufficient if the attempt is made in the spring. It is not so. These worms may come out during the warm days of winter, and also in the spring. The females cannot get up the trees without crawling, for they are not provided with wings.

* Report Conn. Board of Agriculture for 1866, p. 85.

"There have been practiced different methods for the protection of our elm trees, and the cheapest and best is to cover the body of the tree two or three feet from the ground with paper smeared with printers' ink. This is better than the application of tar, for it remains sticky much longer. It does not gloss over like tar. It is the cheapest application that can be made, and has been tried with success in some parts of New Haven City. It must be put on in the fall and in the spring.

"The trees about the colleges were provided with a leaden rim surrounding the tree, fitting it like a collar, and having a hollow filled with oil between the rim and the tree. The idea was that the canker worm would tumble off in trying to climb around the shelving edge, or if he succeeded in getting around this that he would die in attempting to cross the intervening fluid. These were found not to work well.

"The best protection against these worms and other pests is to have their natural enemies flourish at the same time. There is an enemy of the canker worm, a green beetle, which has an enormous appetite, for they eat all the while. These beetles and the birds which live upon the pests of our trees are our best safeguards against the attacks of the worm.

"There is also a fly called the ichneumon fly, which attacks the eggs of the canker worm and blights them. All these enemies of the canker worm kill it, and diminish their numbers, so when it is noticed that during some seasons our trees are comparatively free from the worm, you may be sure that this decrease is owing to the fact that their natural enemies have increased in a corresponding ratio. When these enemies of the worm also die off, then you will notice that the elm trees are beginning to be laid bare again. And as one end of the scale goes up, the other end goes down."

Mr. T. S. Gold* made the statement that canker worms are abundant only on light soils, and advised as remedies fall plowing and the use of guards around the trunks treated with oil or tar, to prevent the wingless females from ascending to lay their eggs. At a similar meeting in 1881, Mr. P. M. Augur advised† spraying with a weak solution of Paris green or London purple as soon

* Report Conn. Board of Agriculture for 1866, p. 204.
† *Idem* 1881, p. 334.

as the young leaves appear. Three years later, the same speaker recommended* these poisons at the rate of from eight to twelve ounces in a forty-gallon cask of water.

In 1896, the writer advised† spraying the foliage with arsenical poisons and applying to the trunks of the trees bands of cloth, or paper covered with tar or printers' ink, to prevent the females from ascending. Later, tests of various substances were made, and it was found that printers' ink was about as satisfactory as anything that could be obtained for the price. Odds and ends of ink, consisting of various colors left over from job work, are sold under the name of "tree ink" at a lower price than that usually charged for printers' ink, and this is just as good for this purpose. It will harden, however, after a short time, and the writer found that by mixing with it a non-drying petroleum oil it could be kept longer in a viscid state. The oil could also be applied with a brush to the bands from time to time to keep them in proper condition. Pine tar and a preparation called caterpillar lime caused injury to some small trees, even when applied to a band of tarred paper. This method of banding trees was described by the writer in a paper read at the Fourteenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations at New Haven in 1900, and printed in the proceedings.‡

Since then a substance known as "tree tanglefoot" has been placed upon the market, and though this is a proprietary article, it is difficult to make anything for the price that equals it. It remains sticky for a long time and causes no injury to the tree, even though applied directly to the bark.

Modern Treatment.

We must still advise the same general lines of attack as were recommended years ago, namely, spraying the foliage with arsenical poisons and placing sticky bands around the trunks to prevent the ascent of the wingless females. Different substances can now be used for the purpose. The spraying method is advised in the apple orchard, where spraying is generally practised any-

* Report Conn. Board of Agriculture for 1881, p. 390.
† Report of this station for 1896, p. 235.
‡ Bulletin 99, Office of Experiment Stations, U. S. Dept. of Agriculture, p. 160.

way on account of codling moth and tent caterpillar. In Bailey's experiments* in Central New York, Paris green (one pound in two hundred gallons of water) gave as good results as a mixture twice as strong, and seemed more effective than lead arsenate used in similar proportions. In spraying trees at Stonington to kill gypsy caterpillars, last summer, lead arsenate was used in the proportions of three pounds in fifty gallons of water, and this was later increased to five pounds. Some of the trees and shrubs were infested with canker worms, which were readily killed. Quaintance's experiments† also confirm this.

Canker worms can be controlled by a careful and thorough spraying with lead arsenate (three pounds in fifty gallons of water), or with Paris green (one pound to fifty gallons of water, three pounds lime), but these quantities can be doubled if desired.

Where it is impracticable to spray the trees, canker worms can be controlled absolutely by sticky bands, if properly used.

How to Band the Trees.

The sticky substance may be applied directly to the bark, and this is often done in orchards and on woodland trees, but on shade trees on private places it is often desirable to remove the bands when they are no longer needed, and this can be done if the sticky material is placed upon a separate band. Tarred roofing paper answers the requirements, as it does not absorb the "tree tanglefoot" as cloth would do, and it is fairly durable. If the paper is placed around the trunk, the rough bark has many crevices through which the females can crawl. Hence the reason for using cotton batting to stop these.

First place around the trunk about six feet from the ground a strip of cotton batting (cheapest grade) about two inches wide. Then cover this with a band of single-ply tarred paper about five inches wide, fastened at the lap with three sharp-pointed tacks about three-fourths of an inch long. The paper should be drawn snugly enough to press the thick band of cotton into the crevices, but not enough to break the paper. If tacked in many places, the growth of the tree will break the paper. Of fifty-five bands applied in this manner none needed renewing for two seasons,

* Bulletin 101, Cornell Expt. Station, p. 496.
† Bulletin 68, Bur. of Entomology, U. S. Dept. of Agriculture, p. 21.

and while many had to be replaced the third year, fully one-half of them lasted through the fourth season.

"Tree tanglefoot" should then be spread upon the band, preferably the upper two thirds of its width, with a wooden paddle, leaving a smooth coating about one-eighth of an inch thick. If spread too thin it will become ineffective much sooner, and cannot be renovated by combing or scratching the surface, as is possible with a thicker coating. But the effect of the weather after a time will dry or harden the surface of the band so that it is necessary to add more "tanglefoot." Especially is this necessary where the moths are abundant and adhere to the bands in such numbers as to entirely cover the viscid surface and render it ineffective. Usually scratching or combing the surface of the "tanglefoot" every three weeks will keep it in good condition. The method of applying bands is shown on Plate XLVIII. Such a band as has just been described can be removed from the tree at any time without leaving any sign or scar, while if applied directly to the bark it will show as a disfiguring mark for many years. Moreover, so much more "tanglefoot" is necessary to fill the cracks of the bark and thus make an effective barrier that it costs about as much to apply it directly to the bark. No doubt some reader will ask or wonder why it is advised that the paper be so much wider than the cotton band. There are two reasons. In the first place, a narrow band of cotton fills the cracks just as well as a wide one and costs less. In the second place, it is unsightly to use a cotton band which shows either above or below the edges of the paper. For very large trees it is well to use a wider strip of paper, say six or seven inches, and for a very small tree four inches is ample width, but five inches is about right on the average.

In Connecticut the bands should be applied during October, as the moths appear about the first of November, and they should be kept in a viscid condition during this and the following months, and again in March, April, and the first part of May, in order to catch the spring females and the newly-hatched larvæ. A band of thick cotton batting is quite effective in preventing the ascent of the females, but this is more unsightly than the dark bands described above.

A band of wire cloth netting tacked by its upper edge so as to allow the lower margin to stand out one or two inches from the

bark is also an effective barrier, but unless the eggs are destroyed below the band before hatching, the young larvæ will crawl through the meshes and up the tree.

Cost of Banding Trees.

The sticky bands of tarred paper and cotton batting such as have been described in this paper were applied to trees on the station grounds in October. All trees, including fruit trees, were banded, nearly one hundred in number, and averaging rather small. "Tree tanglefoot" costs from twenty-four to thirty cents per pound according to the quantity purchased, and is put up in one, three and twenty pound cans. Tarred paper costs seventy-five cents per roll, cotton batting ten cents, twelve-ounce upholstery tacks ten cents per package.

On the basis of these figures the bare cost of banding the trees was a little more than ten cents per tree, of which about half was for labor and half for materials. The cost will vary, of course, with the size of the trees and the cost of materials and labor.

Summary.

Canker worms have caused damage to trees in New England for more than one hundred years, according to our records, and from time to time during that period they have been injurious. Many orchard, shade and woodland trees were stripped in 1908. In the early days it was known that the females were wingless, and that they crawled up the trees to lay eggs, and tar bands were recommended as a remedy.

Though it was known that some of the adults appeared in fall and some in spring, they were at first supposed to belong to the same species, and it was not until 1874 that Dr. Riley published an accurate and detailed description of their characters, thus showing them to be distinct species.

The spring canker worm, *Paleacrita vernata* Peck, has long been destructive in the Southern and Middle Western States. The adults emerge from the ground during March and April and the females lay their whitish eggs, about fifty in number, in loose irregular clusters, usually under the edges of the rough bark. The eggs hatch early in May and the caterpillars feed upon the leaves. They are green, brown or dark gray in color, marked

longitudinally with fine pale lines. They have *no pro-legs on the eighth segment.* They spin down on fine silken threads when disturbed, and become full grown about June 1st, going into the ground, making a simple earthen cell lined with a few threads of silk. The male pupa is tipped with a simple spine.

The adult male has a wing spread of about an inch and is of a brownish gray color. Wings are thin and semitransparent, with the markings rather indistinct. Female, brown or gray, with a black or dark brown stripe along the back and a two-jointed exsertile ovipositor.

The fall canker worm, *Alsophila pometaria* Harris, is far more common in New England than the spring species, though both occur. The adults appear in November and December, and the females lay dark gray eggs on the trees in compact clusters of about one hundred, arranged in rows, and each egg fastened by one end to the bark. The caterpillars hatch from the eggs early in May, and vary in color from light green to dark gray or brown, marked lengthwise with fine white lines. *A pair of pro-legs* is borne on the eighth segment. Like the spring species, they spin down on silken threads, and are about three-fourths of an inch long when full grown, about June 1st, when they go into the ground to pupate. The pupa is stouter than in the spring canker worm and the spine is curved and forked. It is enclosed in a silken cocoon interwoven with soil particles, making a strong cell.

The adult male is lightly larger than *vernata,* brownish gray in color, with a slight purplish tinge, wings are firmer, less transparent and darker gray in color. The fore wings are crossed by two whitish bands, the distal one being offset inward on the costal margin, forming a white costal spot. Female without wings, markings, or visible ovipositor, and uniform ash-gray in color.

Both kinds of canker worms devour the leaves of trees in the same way, and attack a large number of different kinds of trees. The fall species seems to be especially fond of apple orchards.

Spraying the trees with Paris green was first advised in the early eighties, while bands covered with tar and printers' ink have remained in use.

At the present time the best treatment for orchards is to spray with lead arsenate (three pounds in fifty gallons of water or

Bordeaux mixture), or with Paris green (one-half pound in fifty gallons). Shade and garden trees may be cared for by placing a band of sticky material, one of the best substances being "tree tanglefoot," about the trunk. This can be placed on the bark, or preferably a band of cotton batting should be placed around the trunk covered with a strip of tarred paper five inches wide, upon which the sticky material is placed. Banding is inexpensive and effective where the bands are properly cared for.

Where the fall canker worm is the destructive species, the bands should be applied during October, and kept in a sticky condition during November and December and again during March, April and May, in order to prevent both the adult female and the newly hatched caterpillars from ascending the trees. To control the spring canker worm, the sticky bands need be effective only during March, April and May.

FURTHER TESTS OF GASES TO DESTROY SAN JOSÉ SCALE ON NURSERY STOCK.

In the Report of this station for 1907, page 270, is an account of the value of various gases for fumigating nursery stock to destroy the San José scale. It was stated therein that the tests were preliminary and that conclusions based on them were scarcely warranted, yet that they indicated the desirability of making further tests with smaller quantities of carbon disulphide and carbon tetrachloride, and of longer fumigating periods with the former. Following along this line, therefore, the present paper deals with additional tests made during the last week of April, 1908. All trees were apple, and more or less infested with the scale, much more so than the trees used in the tests last year. This fact may in some measure explain the results, as it is probable that where trees are slightly infested a careful fumigation will often kill all of the scales, whereas with the same treatment the gas might not be able to reach and destroy every individual insect where the bark is thickly covered by them.

The work of fumigating and counting the scales was done by Mr. B. H. Walden.

The roots were in good condition, except where otherwise noted, and the buds had started but little. Portions of the trunk were

cut from each of nine different trees and the scales examined, with the following result:

Alive	7	4	3	3	17	8	5	26	40 = 113
Dead	18	10	4	7	5	16	4	8	10 = 82

Number alive = 58 per cent. 195

Ten trees were used in each test with carbon disulphide and carbon tetrachloride except in No. 6, which had nine trees. Five each were used in the acetylene tests, making in all two hundred and twenty-four trees which were fumigated. These were set in nursery rows on the station grounds, where they could be watched during the season.

Carbon Disulphide.

The liquid was volatilized by putting it in iron frying pans heated to about 100° C., according to the method described in last year's report. The pans were placed on frames above the trees and near the top of the case. The fumigating was done in tin cases containing about six cubic feet. The figures in the table, as well as those in the text, are calculated for one hundred cubic feet. The quantities used, fumigation period and results, are shown in Table I. The effect upon the scales corresponds with the results of last year's tests in that ten fluid ounces or less of the liquid does not kill all of the scales unless acting during a long fumigation period. Thus in Nos. 1 and 2, ten ounces acting for one and two hours left over twenty per cent. of living scales, but in No. 5, where the same quantity was allowed to act for four hours, all were dead. In Nos. 6 and 9, five ounces did not kill all of the scales in two and four hours, but after being treated for six hours none survived.

As was the case in last year's tests, twenty or more ounces acting for one hour or longer killed all of the scales. Where thirty ounces acted for two hours, one tree (ten per cent.) failed to grow, though it started and afterward died.

Though not proven, our tests indicate that the limitations of carbon disulphide vary from a minimum of twenty fluid ounces for one hundred cubic feet with a fumigation period of one hour to a maximum of thirty fluid ounces for two hours. Less than the minimum may not kill all the scales, and more than the max-

imum may result in killing or injuring the trees. It should be understood that these tests apply only to apple and peach, and chiefly the former, and against the San José scale and no other insect.

Carbon Tetrachloride.

This liquid was used in exactly the same way as the carbon disulphide, the same metal cases and heated frying pans being used. The quantities used, period of fumigation and results, are given in Table I. The results do not correspond very closely with those obtained in last year's tests, in that some scales survived in each case, where last year all were killed. Last year it seemed that carbon tetrachloride was a promising material, and its good qualities were mentioned in the Report. Though further trials may still prove it to be of some value as an insecticide, in the light of the 1908 tests it does not appear as promising as it did a year ago. Nevertheless, the figures are given here for what they are worth without further comment than to state that carbon disulphide, in spite of the inflammability and bad odor, seems to be more desirable for fumigating nursery trees to kill the San José scale than carbon tetrachloride.

Acetylene.

This was generated in a granite iron dish from crushed calcium carbide, the largest pieces being about one inch in diameter. Instead of the metal case a long wooden box was used. In Test No. 21 this box was used right side up with a tight cover, the carbide weighed out and placed in the dish, and the water poured in by means of a funnel through a hole in the cover. In the other tests the box was inverted over the trees on the ground, and the earth banked up around the edges of the box to make it tight. A small box was sunk in the ground under the middle of the long box, and this, projecting outward from one side, served as a place to introduce the materials. The opening in the small box was then quickly covered and banked with earth.

The data regarding the tests with acetylene will be found in Table I, but do not show this gas to be very effective in destroying the scale when used in the quantities and for the fumigating periods used in this experiment.

It does not appear that any of the gases that can be commonly and simply generated will supersede hydrocyanic acid gas for fumigating nursery stock.

TABLE I.—TEST OF GASES FOR FUMIGATING STOCK.

EXPERIMENTS WITH CARBON DISULPHIDE.

No. Expt.	Fluid ounces of liquid used for 100 cu. feet.	Fumigating period.	Number of Generating dishes.	Number of trees.	Effect on Scales.			Effect on Trees.	
					Alive.	Dead.	Per cent. Alive.	Alive.	Dead.
1	10 fluid oz.	1 hour	1 heated to 100°C.	10	35	138	20.2	10	0
2	10 "	2 "	1 " "	10	56	192	22.5	10	0
3	20 "	2 "	1 " "	10	0	123	00.0	10	0
4	20 "	1 "	1 " "	10	0	159	00.0	10	0
5	10 "	4 "	1 " "	10	0	112	00.0	10	0
6	5 "	4 "	1 " "	9	21	200	09.5	10	0
7	30 "	1 "	1 " "	10	0	101	00.0	10	0
8	30 "	2 "	1 " "	10	0	123	00.0	9	1*
9	5 "	2 "	1 " "	10	30	123	19.6	10	0
10	5 "	6 "	1 " "	10	0	160	00.0	10	0

EXPERIMENTS WITH CARBON TETRACHLORIDE.

11	10 fluid oz.	2 hour	1 heated to 100°C.	10	12	116	09.0	--	0
12	20 "	2 "	1 " "	10	4	172	02.2	9	1*
13	30 "	1 "	1 " "	10	28	123	18.5	10	0
14	30† "	2 "	1 " "	10	1	180	00.5	9	1
15	20 "	1 "	1 " "	10	3	111	02.6	10	0
16	5 "	2 "	1 " "	10	22	126	14.8	10	0
17	10 "	1 "	1 " "	10	29	200	12.6	10	0
18	10 "	4 "	1 " "	10	46	161	22.2	10	0
19	5 "	4 "	1 " "	10	33	175	15.8	10	0
20	5 "	6 "	1 " "	10	12	143	07.7	10	0

EXPERIMENTS WITH ACETYLENE.

21	40 oz. ‡av.	1 hour	1 heated to 100°C.	5	14	28	33.3	5	0
22	80 "	1 "	1 " "	5	22	85	20.5	5	0
23	120 "	1 "	1 " "	5	15	74	16.8	5	0
24	80 "	2 "	1 " "	5	15	50	23.0	5	0
25	80 "	½ "	1 " "	5	24	85	22.0	5	0

* Tree started to grow, then died.
† More than one-fourth of liquid had not volatilized at end of period.
‡ Of calcium carbide.

MOSQUITO WORK IN 1908.

In April, a request was received from Dr. John B. McCook of Hartford, Surgeon of the First Regiment, Organized Militia, State of Connecticut, for a report regarding the breeding of *Anopheles* in the vicinity of the state rifle range in East Haven. Though this territory was examined in a general way in 1904, and nothing was found there, it was thought best to make another survey of the place, as plans had been made for the regiment to be in camp there for a week in July.

Mr. Walden visited the place on June 24th, and not finding any serious mosquito breeding-places, a report to this effect was sent to Dr. McCook. Afterward Dr. McCook furnished us a blue print map of the region, and Mr. Walden again visited the range in order to locate more definitely some of the pools. Thus the more important features were mapped and numbered, and explanatory notes were sent to Dr. McCook under date of August 13th. Following is Mr. Walden's report:

The Mosquito Breeding Problem at the State Rifle Range, East Haven, Conn.

The state rifle range at East Haven was examined June 24th and again August 12th, for mosquito breeding-places. At the first examination no mosquito larvæ were found, but on the second date both *Anopheles* and *Culex* larvæ were found in two places. In a dry season the range is fairly safe from mosquito breeding, but there are several low areas which in wet seasons would hold water long enough for mosquitoes to breed.

During the warm part of the season only about a week is required for mosquitoes to develop from the egg to the adult. Therefore, any place that will hold water for a week or more is liable to breed mosquitoes, and as *Anopheles*, the malarial mosquito, may breed in any place where other mosquitoes breed, it is important that these low areas should be drained. This is a comparatively simple problem. The Farm River, a large stream well stocked with fish, runs lengthwise of the range, and the low places can be drained by running simple open ditches to the river. On the accompanying map the necessary ditches have been indicated. Ditches eighteen inches wide and fifteen inches deep at the point farthest from the river will furnish ample drainage.

These may be made straight, or may curve to follow the natural drainage of the land, as seems best. The only requisites are that the bottom of the ditches be fairly smooth, and have enough fall so as to leave no places for the water to stand in pools. The edges should also be kept fairly clean.

Notes regarding a few details are as follows:

There is a depression ten or fifteen feet across, at the side of, and partly under, the bridge where the driveway crosses at the south end of the range. The bottom is more or less covered with rocks, between which the water stands. Water was present here June 24th, just after a long dry period. No mosquito larvæ found at this time. On August 12th larvæ of both *Anopheles* and *Culex* were present in small numbers. Filling the depression with dirt to the top of the rocks would make it safe.

A short distance north is a large brush-covered pondhole, which, though dry at the time of both examinations, would probably hold water even in a normally wet season. It will require a ditch several feet deep to drain it across the skirmish run. If this forms too much of an obstruction a tile or covered drain could be constructed.

Northeast from the building occupied by the quartermaster's department a low area extends inland from the main stream, in which is much standing water. Grass and weeds occur here, and it is more or less obstructed by fallen trees and brush. *Anopheles* larvæ were present August 12th. A wide ditch could be dug here, and the material used to fill, so as to make abrupt edges. These should be kept clean, so that the fish will be able to reach the edges.

To the north is a low area which can be easily drained.

Towards the north end of the range is an old choked ditch which should be cleaned out if there is any standing water in the vicinity.

The edges of the main stream should be kept clean from anything that would obstruct the fish, and any other places where water stands should be drained or filled as recommended above.

It would be hard to estimate the cost of eliminating all breeding-places, but to carry out the above recommendations, using simply open ditches, would probably cost less than one hundred dollars. Tile drains would of course cost much more, and are not necessary to do away with all possible mosquito breeding-places.

The Beaver Swamp Region.

Beaver Swamp, near New Haven, has long been regarded as unsanitary and as a source of malaria, even before the cause of malaria and its methods of transmission were known. In the mosquito survey made by this station in 1904,* this swamp was found to be the most prolific source of *Anopheles,* or malarial mosquitoes, about New Haven. The Board of Park Commissioners has been working for some time to have the city purchase this land on the grounds of sanitation, with the expectation that ultimately it may be used for park purposes. Thus a small area has been purchased each year for several years, until now nearly all of the land between Munson Street on the south and Willis Street on the north, extending from Fournier Street on the west to the proposed extension of Sherman Avenue on the east, is owned and controlled by the city.

In 1904 the results of our examination were made known to the Park Commission and to the health officer, and after another examination in 1908 the facts were communicated to the mayor, but so far nothing has been done by the city authorities to put this area in a sanitary condition.

The accompanying map (Figure 10), explained by the following numbered notes, shows where the more serious breeding-places are located:

No. 1. Small spring-like depression about three by five feet, containing *Culex* larvæ.

No. 2. Tested edge of main stream for fifty feet or so. Found a few *Anopheles* larvæ and many *Culex* larvæ.

No. 3. A sedgy depression about ten feet long, containing yellow pond lilies and breeding *Culex* larvæ. In a wet season a much larger area would be flooded.

No. 4. Large boggy area more or less covered with water, surrounding large pool with pond lilies growing in it. Found *Culex* larvæ in abundance.

No. 5. A large deep pool in edge of stream, with *Anopheles* larvæ along the irregular edge.

No. 6. A soggy area with more or less water covered with lily pads, sedges, cattails and bushes. Found many *Culex* and a few *Anopheles* larvæ.

* Report of this station for 1904, p. 293.

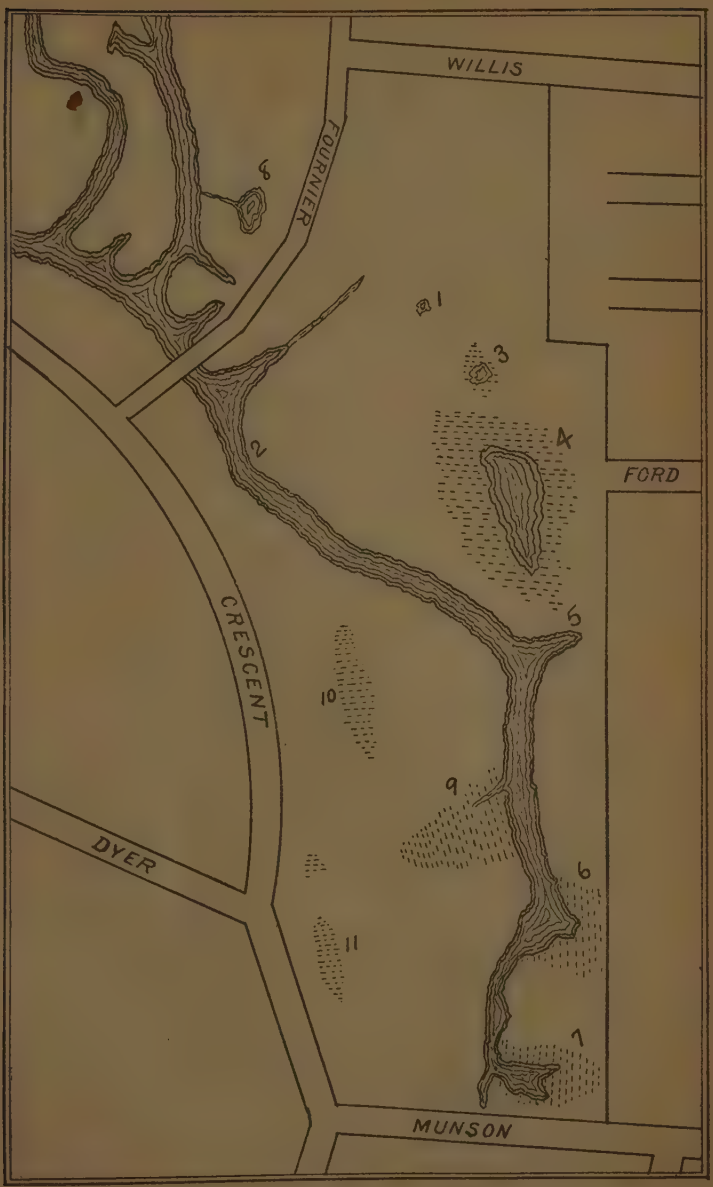


FIG. 10. Map of Beaver Swamp, New Haven, showing breeding-places of the malarial mosquito.

No. 7. A large boggy area covered with cattails and rank growth. In sight of Munson Street. Contains a pond with muddy, soggy edges, so soft that it was impossible to get near enough to test the water. Many bare depressions indicate that water would stand on much of the area in a normal or wet season.

July 18. Again visited the region. Examined No. 5, and found pupæ and larvæ of *Anopheles*.

No. 8. A large pool west of Fournier Street containing fish two to three inches long. Found *Anopheles* larvæ in water cress and grass along the edge.

No. 9. Soggy area with standing water in which *Anopheles* were found.

Nos. 10 and 11. Low areas which contain water early in the season and probably throughout the summer in a wet season.

For a few thousand dollars this entire region could be put in a salutary condition. It is an engineering problem. Though it may not be feasible to drain the bogs entirely, the water can be considerably lowered by draining, permanent pools can be formed and stocked with fish, and if the edges are kept clean, there will be no trouble from mosquitoes.

Notes on Breeding-Places Around Stamford.

On September 23d the writer visited Stamford at the request of Health Officer Dr. F. J. Rogers to look over the possible mosquito breeding-places. In company with Dr. Rogers and Messrs. R. A. Fosdick and J. J. Radley, a trip was made to the chief marsh regions near the city. The map and notes about this area made in 1904 were used for comparison, and though a dry season, no serious breeding areas were apparent.

Before returning we visited a pondhole between Brook and State Streets, north of the railroad, which was mapped in 1904 as being a serious breeding-place. It is a pond which has been partially filled by dumping all sorts of refuse into it. Two or three square rods of water surface remained, and the water was literally filled with *Culex* larvæ. It was estimated that between fifty and one hundred larvæ were taken at a single dip. *Anopheles* were not seen, but doubtless breed here at times. Measures were planned to do away with this nuisance.

INSECTS ATTACKING CUCURBITACEOUS PLANTS IN CONNECTICUT.

Cucurbitaceous plants such as cucumbers, squashes, pumpkins and melons, which are extensively grown in Connecticut, are attacked and injured by a number of species of insects. For several years we have been making observations on them, and the present paper is for the purpose of giving in a few pages a fairly comprehensive account of the principal insect pests of these plants.

For the hasty identification of such insects the following key may be found useful:

BORING IN THE ROOTS AND STEM—

Small, slender larvæ tunneling in the main root or stem below ground .....
Striped Cucumber Beetle, *Diabrotica vittata*, p. 807.

Large, stout larvæ boring in squash stems above ground .....
Squash Borer, *Melittia satyriniformis*, p. 806.

DEVOURING THE LEAVES—

Small (5-7 mm.) yellowish beetles feeding upon the leaves.

Body yellow, marked with three longitudinal black stripes .....
Striped Cucumber Beetle, *Diabrotica vittata*, p. 807.

Body greenish yellow, marked with twelve black spots .....
Southern Corn Root Worm, *Diabrotica xii-punctata*, p. 809.

Large (8-10 mm.) hemispherical beetle, orange marked with black spots, or yellow larva with black spines .....
Squash Lady-beetle, *Epilachna borealis*, p. 810.

SUCKING SAP FROM THE UNDER SIDE OF THE LEAVES—

Small dark green or brownish plant lice, often very abundant .....
Melon Aphis, *Aphis gossypii*, p. 813.

Larger bright green plant lice usually not abundant .....
Squash Aphis, *Nectarophora cucurbitae*, p. 814.

Gray bug with spicy odor (15 mm. when full-grown) .....
Squash Bug, *Anasa tristis*, p. 811.

Small greenish-white scale-like insects on the under leaf surface of plants growing under glass or near greenhouses. Pure-white moth-like adults resting on the leaves, and flying about .....
Greenhouse White-Fly, *Aleyrodes vaporariorum*, p. 815.

The Squash Borer.

Melittia satyriniformis Hübn.

This is the most important enemy of the squash and pumpkin in Connecticut, and causes the vines to wither in July and to die before maturing their crop. Melons and cucumbers are seldom attacked if squashes and pumpkins are plenty.

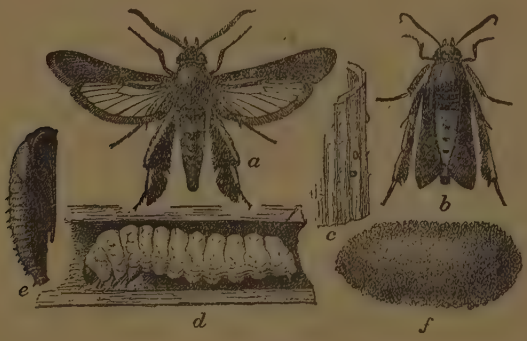


Fig. 11. The squash borer: *a*, male moth; *b*, female, with wings folded as when at rest; *c*, eggs on section of squash stem; *d*, full-grown larva in the stem; *e*, pupa; *f*, pupal cell. All one-third larger than natural size. (After Chittenden, Circular 38, Bureau of Entomology, U. S. Department of Agriculture.)

The adult is one of the clear-wing or sesiid moths, and is shown on Plate L of this report. It has a wing expanse of from one to one and one-fourth inches, and the fore wings are opaque and dark olive green in color with a metallic luster and a fringe of brownish black. Rear wings with transparent cells and a bluish reflection, veins and fringe black. Thorax and antennæ colored about like fore wings. Abdomen reddish brown, legs bright orange, with tarsi black with white bands. When at rest the wings are folded as in *b* of the accompanying illustration (Fig. 11).

This insect is distributed throughout the eastern half of the United States from Canada south to Mexico, and is thought to be a tropical species. The female lays eggs singly on the squash plant during June or early July in Connecticut, but may be abroad at a much earlier date farther south. The eggs are usually laid on the stem, but may often be found on the leaves or buds. The eggs are oval and dull red, and over two hundred may be laid by one moth. From one to two weeks are required for the eggs to hatch, and the larvæ become full grown in about four weeks. The newly hatched larva enters the main stem, where it tunnels through it lengthwise near the base, often going into the leaf petioles which branch from the main stem. As the larvæ increase in size they eat more and more each day, and the plant begins to wilt. This is usually the first sign of the attack, though an earlier examination would show the yellowish excrement which is thrown out of the holes in the stem. The stem usually begins to decay near its base, and is often severed at this point. The full-grown larva is about one inch long, rather stout and soft, is white with a black head and is shown with its injury on Plate L. It goes into the ground one or two inches, where it makes a cocoon of silk, to which adhere small particles of soil. There is only one generation each year in Connecticut, but in Washington, D. C., there are two broods.

In our experiments several remedies have been tried, including wrapping the stems with tarred paper, placing tarred paper disks around the stems at the base, and painting the stems with a thick mixture of lead arsenate. These three practices did not seem worth while. The only treatment that we can recommend is to plant early squashes for traps to be destroyed later; to cut into the stems, making a longitudinal incision, and killing the borers; to cover the stem with earth one or two feet from the base to induce secondary roots that will support the plant in case it should become severed at the base. It is also advisable to destroy all old vines as soon as the crop is secured.

The Striped Cucumber Beetle.
Diabrotica vittata Fabr.

A frequent and serious enemy of all cucurbits is the striped cucumber beetle, *Diabrotica vittata*. Soon after the seedling

plants appear the beetles begin to feed upon the leaves and tender stems, eating away the epidermis, often causing the plants to wilt and die. They even burrow into the ground and attack them before they come up.

The beetles are about one-fifth of an inch long, with thorax and wing-covers yellow, the latter with three black longitudinal stripes; the head is also black. At the time the beetles are feeding upon the young plants they are also mating and laying eggs on the stem just below the surface of the ground. The larvæ

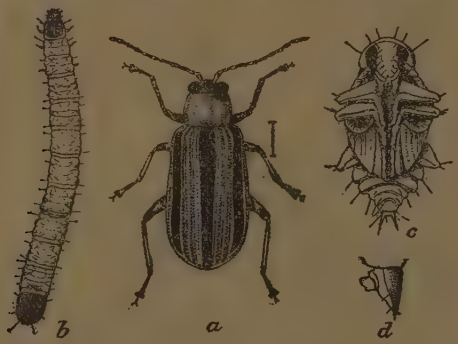


FIG. 12. The striped cucumber beetle: *a*, adult beetle; *b*, larva; *c*, pupa; *d*, side view of anal segment. All greatly enlarged. (After Chittenden, Circular 31, Bureau of Entomology, U. S. Department of Agriculture.)

hatching from these eggs are borers in the roots of the plants, sometimes causing considerable injury. A sample of this work is shown on Plate LI. Though the complete life history of this insect is not well known, it is believed that the larval period lasts for about a month. The full-grown larva is about one-third of an inch long, and is slender and whitish, with a black head (see Fig. 12). Pupation occurs within the ground. The pupa is white, like the larva, and the pupal stage lasts about a week. There are two generations in Connecticut each season, and the beetles are often found in large numbers late in the season assembled under the dead leaves of the plants. Melons, cucumbers, squashes and pumpkins are attacked.

The remedies consist either in keeping the beetles away from the plants or in the use of poison. The latter method is the one

practiced by most large growers. Paris green may be mixed with air-slaked lime or plaster at the rate of one pound of poison to seventy-five pounds of plaster, and the mixture sifted upon the plants. This, of course, cannot be used before the plants come up, and when the beetles are extraordinarily abundant much damage will often result to the plants in spite of the application of poison. Lead arsenate mixed with water at the rate of three to five pounds in fifty gallons of water and sprayed or sprinkled upon the plants is usually an excellent remedy.

In order to keep the beetles wholly away from the plants it is necessary to cover them with frames of netting. A barrel hoop may be cut in two equal parts and fastened together at right angles, the ends set in the ground, and the frame covered with netting. The ends of these semicircular hoops may be fastened to another hoop lying horizontally in order to make a portable frame, and the whole covered with netting. Boxes and various other forms of wood may be designed into protectors for this purpose, but they are chiefly for use in the home garden, and must be placed over the hills before the beetles appear. In some cases it is possible to drive away the beetles by a frequent dusting of the plants with fine coal ashes, air-slaked lime, or insect powder, and some growers use trap plants and practice burning all old plants and rubbish in the field after the crop is harvested.

The Southern Corn Root Worm or Twelve-Spotted Cucumber Beetle.

Diabrotica xii-punctata Oliv.

This insect is not usually included in a list of insects injurious to cucurbitaceous plants, but it has been so abundant in certain fields which have come under our observation that surely considerable damage must have been done by it, and for that reason it is listed here.

For many years the adults have been known to feed upon a large number of plants, including nearly all of the common vegetables and some of the fruit blossoms and field crops. The larvæ are a serious pest of corn roots in the Southern States, and also attack rye, millet and garden beans, sometimes doing considerable damage.

The eggs are laid in the soil, each female laying about seventy-five eggs, which hatch in about three weeks, and the larvæ tunnel in the roots of corn and other plants for nearly four weeks, pupating in an earthen cell from which the adult beetle emerges about a week afterward.

The adult beetle is somewhat larger and stouter than the striped cucumber beetle, and averages about 7 mm. in length. The wing-covers are greenish yellow, marked with twelve black spots arranged in three transverse rows, and varying in size. Thorax bright yellow, head black. Legs, except thighs, and antennæ blackish.

Where abundant enough to cause injury, the same remedial measures used against the striped cucumber beetle should be practiced.

The Squash Lady-Beetle.

Epilachna borealis Fabr.

Nearly all of the lady-beetles are carnivorous, and are considered beneficial because they feed upon injurious insects such as plant lice and scale insects. The squash lady-beetle, however, is an exception, and feeds upon the leaves of cucurbitaceous

Fig. 13. The squash lady-beetle: *a*, larva; *b*, pupa; *c*, adult beetle, three times natural size; *d*, egg, four times natural size; *e*, surface of same highly magnified. (After Chittenden, Bulletin 19, Bureau of Entomology, U. S. Department of Agriculture.)

plants, but does more damage to squash than to the other plants of this group.

The adult beetles hibernate under bark or in other sheltered places, emerging in June, and toward the end of the month lay

their eggs on the under side of the leaves. The eggs hatch in about twelve days, and the larvæ at once commence to feed upon the leaves, attacking them from the under side. The larvæ appear about the middle of July and become full grown early in August, when they assume the pupa stage, which lasts six days before the adults emerge.

The adult is nearly hemispherical in shape, slightly oval, about one-third of an inch long and slightly over one-fifth of an inch broad. It is greatly convex, and of a yellowish or reddish brown color marked with black spots, seven on each wing-cover and three or four smaller ones on the thorax.

The larva is yellow, with black branching spines, and about half an inch in length. The spines are arranged in six longitudinal rows. This insect is shown in Figure 13 and on Plate LIII c. Its work is shown on Plate LII b.

The larvæ feed chiefly on the under sides of the leaves late in July and early in August, and the adults are generally found at the same time, as well as both earlier and later, feeding upon the upper surface. The adult has the peculiar habit of marking out with its mandibles a definite area on the leaf and then feeding within this area. It is thought that this procedure causes the tissues to wilt, and that this somehow better suits the insect.

A brief account of this insect was printed in the Report of this station for 1898, p. 269, and more extended accounts of it have been published by Professor John B. Smith, in Bulletin 94 of the New Jersey Station, and by Dr. F. H. Chittenden, in Bulletin 19, New Series (p. 11), of the Bureau of Entomology at Washington.

The squash lady-beetle can be controlled easily by the use of the arsenical poisons.

The Squash Bug.

Anasa tristis De Greer.

The squash bug, or "stink bug," is a serious pest of squashes and pumpkins, though it does not as a rule attack melons and cucumbers. It punctures the tissues of a vein on the under side of a leaf and, sucking out the sap, causes the leaf to wilt badly and die. The adult bugs are about three-fourths of an inch in length, dark gray or brownish, and are rather conspicuous objects on the under surface of the leaves. The eggs are dark brown and

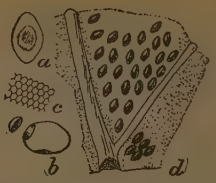


FIG. 14. Egg of squash bug as they are laid on the under side of a leaf. Enlarged. (After Chittenden, Bulletin 19, Bureau of Entomology, U. S. Department of Agriculture.)

FIG. 15. Nymphs of the squash bug; different stages, about twice natural size. (After Chittenden, Bulletin 19, Bureau of Entomology, U. S. Department of Agriculture.)

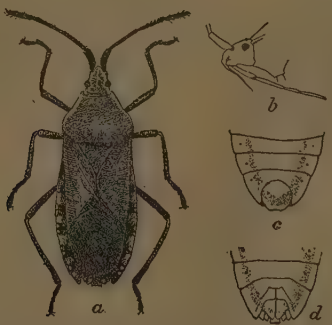


FIG. 16. The squash bug: *a*, mature female, twice natural size; *b*, side view of head showing proboscis; *c*, abdominal segments of male; *d*, same of female. Enlarged. (After Chittenden, Bulletin 19, Bureau of Entomology, U. S. Department of Agriculture.)

shining, and are laid in more or less regular rows in masses containing between twenty and forty each, as shown in Figure 14 and on Plate LII a. The young nymphs hatching from the eggs are ash-gray in color and pass through five distinct stages before reaching maturity, during which time they are found underneath the leaves, getting their nourishment from the sap. The nymphs and adults are shown on Plates LII and LIII. See also Figures 15 and 16.

The adults are hard to kill, but the young nymphs are quite susceptible to applications of kerosene emulsion. Hand-picking and the use of plant protectors such as are used against the striped cucumber beetle are to be advised. Above all, clean-cultural methods, such as burning the old vines after the crop is harvested, are essential.

The Melon Aphis or Plant Louse.

Aphis gossypii Glover.

This is really one of the worst insect enemies of this class of crops. It is nearly always present, and being on the under surface of the leaves, where it sucks the sap, it escapes notice until the leaves begin to curl on account of it. On account of its position and the curling of the leaf, it is extremely difficult to strike it with a spray, though this can be done with the proper outfit. The melon aphis is much more injurious to cucumbers and melons than to squashes and pumpkins. When first born, the insects are yellowish green, but they soon take on a darker tinge and finally become brown. This aphis is pronounced by Chittenden* the most injurious plant louse in this country, and it attacks a great variety of plants, among which are cotton and several kinds of vegetables, in addition to the melon and cucumber. Besides these, it is found upon, and is doubtless able to subsist upon, a large number of common weeds. The entire life history of this insect is not known. The species is able to multiply so rapidly that plants are often very seriously injured in a short time, and late in summer it usually disappears very suddenly. See Figure 17.

Our common lady-beetles and syrphus flies prey upon the melon aphis.

* Circular 80, Bur. of Entomology, U. S. Dept. of Agriculture, 1906.

The most promising lines of treatment are as follows:

Spray the leaves from beneath with kerosene emulsion.

Cover the vines with boxes or tubs, and fumigate with carbon disulphide or hydrocyanic acid gas.

Dust with insect powder or tobacco dust applied by means of a powder gun. Place tobacco stems on the ground around the plants.

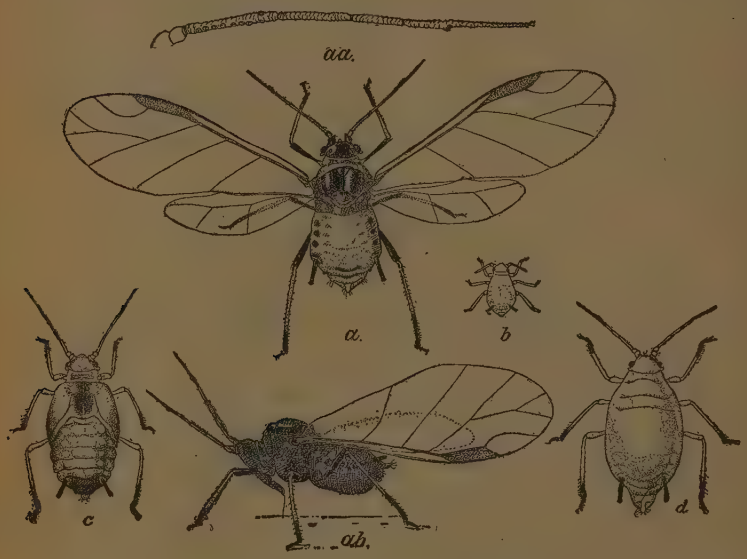


FIG. 17. The melon aphis: *a*, winged female; *aa*, enlarged antenna of same; *ab*, dark form, side view; *b*, young nymph; *c*, last stage of nymph; *d*, wingless female. All greatly enlarged. (After Chittenden, Circular 80, Bureau of Entomology, U. S. Department of Agriculture.)

THE SQUASH APHIS.

Nectarophora cucurbitæ Middleton.

This is a light green species, larger than the melon aphis. It is found chiefly on squashes and pumpkins, though not as a rule causing much damage. The same treatment advised for the melon aphis may be used against this species.

The Greenhouse White-Fly.

Aleyrodes vaporariorum Westw.

Cucurbits growing under glass or out of doors near greenhouses are often attacked and considerably injured by this white-fly. The insect is found on the under sides of the leaves, where the eggs are laid and where the nymphs attach themselves to the leaves. They are very light green, almost white, oval, and resemble scale insects. The empty pupa skins remain on the leaf, and these are silvery white. Adults are pure white and mealy in appearance, resembling tiny moths. They rest upon the under surface of the leaf, where they lay eggs, but fly about when disturbed.

Descriptions and figures of this insect will be found in the Reports of this station for 1902, p. 148, and for 1906, p. 275.

Frequent spraying of the under surface of the leaves with soap and water (one pound in eight gallons) will kill the adults and larvæ and keep the pest in check. Fumigating greenhouses with hydrocyanic acid gas, using one-half ounce of cyanide for each one thousand cubic feet of space, with an exposure of three hours, is perhaps the most effective remedy under glass, but this must be repeated frequently, because the eggs are not all killed by a single treatment, while if more cyanide be used or a longer exposure given, there is danger of injuring the plants.

THE ELM LEAF BEETLE.

Galerucella luteola Müll.

During the past summer (1908) the elm trees of Connecticut have been injured more seriously by the elm leaf beetle than for several years. Many persons thought that the pest had run its course, and that never again would it do much damage to the shade trees of this part of the country. But they were mistaken. In some parts of the state, and especially along the coast, the elm trees were partially defoliated by canker worms in May, with more or less feeding, of course, by the adult elm leaf beetles. The canker worms disappeared about June 1st, and were followed immediately by the newly hatched larvæ of the elm leaf beetle, which devoured the green substance of the under side of the leaves, in many cases completing the defoliation of the trees.

The season was a dry one, and though most of these trees put out a sickly growth of new leaves, it would have been much stronger in a wet season, and therefore less damaging to the trees.

Specimens of the elm leaf beetle were received from eleven different correspondents, representing the following parts of the state: Branford, Bridgeport, Ellington, Hartford, Meriden, Moosup, New Canaan, North Stonington, Rowayton and Wapping. From three of these localities (Branford, Meriden and Moosup), specimens of natural enemies of the beetle were received. These are discussed on page 821.

In addition to the samples received during the season, this office has received and answered fifty-five letters and many telephone calls regarding the pest. The inquiries came from all parts of the state, though most frequently from the southern half, Waterbury reaching first place in regard to the number of inquiries.

As no comprehensive account of the elm leaf beetle has been published in the later station Reports, and only scattered notes have been given therein from time to time, it was thought best to include the matter here. A portion of this paper appeared as Bulletin 155 in June, 1907, but a number of additions have been made to it as here given.

HISTORY AND DISTRIBUTION IN AMERICA.

The elm leaf beetle was introduced into this country probably more than seventy years ago. In its native country, Europe, where it had long been known, it had from time to time caused serious injury in Italy, Austria, and the southern portions of France and Germany. In Northern Europe the insect occurs sparingly, but can hardly be called a pest. Harris states* that the elm leaf beetle attacked and seriously injured the elm trees of Baltimore, Md., in 1838 and 1839. The beetle seemed to spread chiefly northward, though slowly, until Southern New England was reached in the early nineties, and much damage done. In the coast towns of Connecticut many fine old elms, including some historic trees, were killed by its depredations. Stamford, Norwalk, Bridgeport, Stratford, Milford and New Haven especially lost many noble trees. Later the inland cities

* Insects Injurious to Vegetation, page 124.

were invaded, and the elm trees ravaged. In New Haven the pest was perhaps at its worst in 1895 and 1896. In 1896 many of the trees on the older streets about the center of the city were sprayed with poison by the street department. The following season the pest was less serious, and continued to subside until 1901, when it was again comparatively destructive. From 1902 it diminished in abundance until 1906, when considerable damage was done to the trees.

So far as is known the distribution of this insect in America is confined to the lower altitudes of Southern New England and the Alleghanian region. From Charlotte, N. C., its southern limit, the elm leaf beetle now extends as far north as North Conway, N. H. Up to this time, however, the beetle has done no particular damage in New Hampshire. Regions generally infested include the whole of Massachusetts, Rhode Island, Connecticut, Southeastern New York, New Jersey, Eastern Pennsylvania, Delaware, Maryland and a portion of Kentucky, though isolated outbreaks have occurred in Western New York, Pennsylvania, West Virginia, Ohio and North Carolina. It is of course found in Virginia, Vermont, New Hampshire, and probably in Maine. Kentucky, therefore, contains the western limit of the distribution of this insect, though we may expect that soon adjoining states may become infested. The insect exhibits a marked tendency to spread farther along river valleys than over mountains, and is distinctly a pest of city and village trees rather than of trees in the open fields and roadsides of the country.

LIFE HISTORY AND HABITS.

The overwintering beetles come out of their winter quarters during the warm days of early spring, mate, and as soon as the leaves unfold they begin to eat small round or oval-shaped holes through them. Many leaves are thus riddled as though shot had been sent through them, and appear like the illustration on Plate LIV b of this Report.

During the latter part of May and early in June females deposit small clusters of yellow eggs on the under sides of the leaves. The period of ovipositing extends over about four weeks, and each female may lay five or six hundred eggs. In about a week the eggs hatch and the young larvæ or grubs feed upon the

under surface of the leaves, eating off the green tissue between the veins and leaving the veins and the upper epidermis, as is shown on Plate LIV a and c.

In about three weeks the larvæ or grubs are fully grown, and crawl down the trunks of the trees or drop from the ends of the branches to the ground and transform to the naked pupa stage. The great proportion of the pupæ are found close around the base of the tree or lodged in the crevices of the rough bark of the trunk and larger branches. Except for being in crevices, they are unprotected. The writer has seen trees in New Haven where it would be possible to gather several quarts of these pupæ at the base of a single tree.

The pupa stage lasts about ten days, then the adult beetles appear, and lay eggs for the second generation, which seldom does much harm in Connecticut. Those emerging late probably do not lay eggs for a second brood, but may be seen crawling and flying about for a time, feeding more or less, but early going into winter quarters, usually in church belfries, attics of houses, barns, sheds or other out-buildings. They also pass the winter in cracks of fences, telephone poles, or under the edges of the loose bark of the trees. In some of the cities worst infested the adults sometimes gather in church belfries in such numbers that they can be swept up by the half bushel. The elm leaf beetle often occurs with the two-spotted lady-beetle in dwellings, simply because they both seek the same kind of a place for hibernation. Correspondents frequently send both species to the writer and desire to know if they are not in some way responsible for the injuries to their carpets. There is, of course, no relationship or similarity in food habits of the three species. The lady-beetle is predatory, and in the larval stage destroys numbers of plant lice, and therefore should never be destroyed. The elm leaf beetles should, of course, be killed wherever they are found.

DESCRIPTION.

The *eggs* are bright yellow in color, bottle-shaped, and resemble the eggs of the Colorado potato beetle, but are smaller. They are fastened vertically to the under side of the leaf in clusters of from five to twenty-five arranged in two or three irregular rows.

When first hatched, the *larva* is dark or nearly black, covered with tubercles bearing black hairs. As the larva increases in size it molts several times and on becoming full grown is about one-half inch long, dull yellow in color, with a pair of longitudinal black stripes along the back. Head, legs, lateral tubercles and two rows of small tubercles between the dorsal stripes are black. The tubercles also bear black hairs.

The *pupa* is about one-fourth inch in length and bright orange yellow in color, with black hairs or spines. It is not enclosed in an earthen shell to protect it, but is found at the base of the tree perfectly naked and wholly unprotected.

The *adult beetle* is light yellow in color when it first emerges, but soon takes on a duller hue, and finally becomes a dull olive green. An indistinct black stripe extends from the base to the extremity of each wing-cover just inside of the margin. Small black spots or markings on the pronotum of the thorax vary greatly in size and shape. Legs and antennæ are yellow.

Eggs, larvæ, pupæ and adults are shown on Plate LV.

EFFECT UPON THE TREES.

It has previously been mentioned that the adult beetles do more or less feeding, always eating holes entirely through the leaves, as is shown on Plate LIV b. This of course injures the tree, but is much less serious than the damage caused by the larvæ, which eat away the under surface of the leaves. The larvæ are always more abundant than the adult beetles, and are more voracious in their feeding habits. The worst infested trees usually drop their leaves in Connecticut about the middle of July. If this happens, and is followed by a rainy season, new leaves will be put out, but in a season of a protracted drought the trees may fail to put forth new leaves. In either case the tree is undoubtedly weakened, and often seriously so. Sometimes the second crop of leaves is devoured by the second generation of beetles, but in Connecticut the white fungus mentioned in another part of this bulletin is apt to serve as an important check to the beetle in a wet season. Two complete defoliations, one succeeding the other, usually kill a tree. Usually, however, the defoliation is not quite complete, and the trees continue to exist in a greatly weakened and devitalized condition. In the cities and

larger towns, on account of further injuries* by horses, by leaky gas pipes in the ground, and pavements which cut off the supply of moisture, many trees have died. In 1901 the writer was called to Norwich, where nearly every elm had died for a distance of about one and one-half miles on a prominent residential street. These trees had been weakened by the constant attacks of the beetle year after year, and a leaky gas main finally destroyed what little vitality remained. Most of the maple trees along the street survived.

In many cases young or newly planted trees seem to be especially subject to attack, and therefore should receive extra attention.

FOOD PLANTS.

Elms constitute the only food plants known for this insect, and the European species suffer more than the American ones. The English elm (*Ulmus campestris*) and its weeping variety known as the Camperdown elm are favorites of the beetle. The writer has seen these trees entirely defoliated in New Haven when the common white, or American elms, were uninjured. The American elm is, however, the next choice, followed by the Scotch elm (*U. montana*), and though no variety is wholly exempt from attack, the winged elm (*U. alata*), the slippery elm (*U. fulva*), the cork elm (*U. suberosa*) and the rock elm (*U. racemosa*) are much less frequently attacked.

NUMBER OF GENERATIONS.

According to Burgess,† "in New Jersey, Professor J. B. Smith has recorded only a single brood and sometimes a partial second brood, while in the latitude of Washington, D. C., according to the observations of Messrs. Riley, Howard and Marlatt, of the Division of Entomology, two annual broods and sometimes a partial third brood have been found."

Dr. E. P. Felt, state entomologist, of Albany, N. Y., finds‡ two well-marked broods and a partial third brood at Albany and Troy, N. Y.

---

* For a discussion of these injuries the reader should consult Bulletin 131 of this station.

† Bulletin No. 4, page 17, Ohio Dept. of Agriculture, Div. of Nursery and Orchard Inspection, 1905.

‡ Bulletin No. 57, N. Y. State Museum, p. 14, 1902.

The writer has not followed out this matter carefully in Connecticut, but all stages are found on the trees during the first half of September, so presumably there are at least two broods, but the egg-laying period of the adults is so prolonged that the lines of demarcation are nearly obliterated. In Connecticut the leaves of the trees severely attacked by the first brood generally turn brown and drop about the middle of July, when the larvæ are descending the trees to pupate.

NATURAL ENEMIES.

One of the most important natural enemies of the elm leaf beetle in Connecticut is a fungus known to botanists as *Sporotrichum globuliferum* Speg. (*S. entomophilum* Peck), which attacks the pupæ and adults in late summer, especially in a moist season. In 1902 this fungus was prevalent, and the following season the elm leaf beetle did little damage to the trees. In 1906 the beetles were abundant, but as the month of July was wet, the fungus developed and killed a great many beetles. Beetles attacked by this fungus are covered with white mold, as shown on Plate LV e.

In 1907 the elm leaf beetle, though doing some damage throughout the state, was much less serious than in 1906, but an extreme drought prevailed, almost no rain falling during July and August, and the fungus could not get in its work. Consequently most of the beetles matured and transformed, and were ready to attack the trees in 1908, doing serious damage. It was also very dry in 1908, and the *Sporotrichum* could not prevail. After a light rain late in July the writer saw a number of infested pupæ and adult beetles, but it was after most of them had transformed and the beetles flown away, and the rain soon dried up, making it impossible for the fungus to continue to develop. These conditions indicate, therefore, that the pest will be abundant and destructive next year, and all citizens should be ready to combat it.

The writer believes that the fungus just mentioned constitutes an important check on the beetle in seasons when there is much moisture at the time of pupation, and this view is also shared by Dr. G. P. Clinton, botanist of this station, who has observed its work in this vicinity.

In Europe there is a minute chalcidid parasite known as *Tetrastichus xanthomelænæ* Rond. which attacks the eggs of

the elm leaf beetle, and at times proves an effective check. After many trials, this parasite has during the past season been introduced into this country through the efforts of Dr. L. O. Howard,* and has been distributed in Massachusetts, New York, New Jersey, and at Washington, D. C. It is hoped that it may survive here and prove an important aid in controlling this pest.

Predatory bugs of at least three species of the genus *Podisus,* called "soldier bugs," feed upon the larvæ and pupæ, and one of these, *P. maculiventris* Say (formerly *P. spinosus* Dall.), the spined soldier bug, was unusually abundant during 1908 and destroyed many larvæ, pupæ, and adult beetles, though of course the proportion destroyed is very small. The spined soldier bug was sent in from Branford, where its attack on the beetles was observed by Mrs. A. J. Tenney; from Meriden and from Moosup, where it had also been found preying upon the elm leaf beetles. From Bridgeport dead beetles were received, having been killed by one of these bugs. The writer observed a number of cases in New Haven where larva, pupa or adult had been attacked by the spined soldier bug, which impaled the victim upon its proboscis and waved it about in the air while sucking out the juice. These bugs were rather common on trees during the last of July and the first part of August, and are shown on Plate LV d. Dr. A. W. Morrill† has published a record of two of these bugs in confinement which during their last nymphal stage destroyed twenty-six elm leaf beetle larvæ, and after becoming adults destroyed two hundred and twenty elm leaf beetle larvæ and seven large caterpillars.

Riley records‡ two species of beetles, *Platynus punctiformis* and *Quedius molochinus,* as preying upon the elm leaf beetle, and states that an assassin bug, *Reduvius novenarius,* sucks the juices of both adults and larvæ upon the leaves, and that the larva of a species of *Chrysopa* feeds upon the eggs.

The praying mantis (*Stagmomantis carolina* Linn.) is also an enemy of the elm leaf beetle in the southern portion of its range.

---

* Journal of Economic Entomology, Vol. I, p. 281, October, 1908.

† Bulletin No. 60, Bur. of Entomology, U. S. Dept. of Agriculture, p. 155. 1906.

‡ Bulletins No. 6, p. 10, and No. 10, p. 13, Bur. of Entomology, U. S. Dept. of Agriculture.

Birds of various kinds are known to feed upon the beetles in their larval, pupal and adult stages. Some of the creepers have been observed apparently feeding upon the pupæ.

REMEDIES.

Spraying with poison. Covering the foliage with some arsenical poison is the only sure means of preventing injury to the trees, and for this purpose arsenate of lead is unquestionably the most satisfactory of these poisons. It remains better in suspension and adheres to the foliage longer than Paris green or London purple, and is less liable to injure it. As there are now several brands of good arsenate of lead on the market, it will no longer pay to make it up each time from lead acetate and arsenate of soda. The standard brands of lead arsenate on the market are as a rule satisfactory and many of them have been used in our tests. If anyone desires to know the chemical composition of these preparations he should consult Bulletin 157, or the Report for 1907, p. 323, of this station, both of which give the analyses of most of the brands which were sold on the market in 1907. Since then a few new brands have been added, some of which have been examined here. It is fair to state that it is safe to purchase any of them if made by well-known and reliable firms, though as the published analyses show, there is considerable difference in the value on account of the composition and each purchaser should obtain guarantees and prices before buying in large quantities. There are also certain differences in mechanical condition which should be considered. Arsenate of lead should be used in the following proportions:—

Formula { Arsenate of lead .....3–5 lbs.
Water .....50 gals.

There are two methods of spraying elms: (1) To spray as soon as the leaves unfold, the treatment being aimed especially at the parent beetles, and to forestall all injury. This treatment should be practiced wherever canker worms are destructive. As growth takes place, new leaves are constantly appearing, and these will not carry poison unless the application is from time to time repeated. This should be done often enough to keep the foliage well coated with poison until July 1st, when growth usually ceases, and both sides of the leaves should be coated.

(2) The other method is to spray the under sides of the leaves very thoroughly about June 1st, or soon after the eggs begin to hatch. This treatment is aimed at the larvæ, and sometimes a single spraying is sufficient, as the poison will remain throughout the season. By it the great bulk of damage will be prevented, but the leaves will show the small holes made by the parent beetles before the poison was applied.

If arsenate of lead cannot be procured and it seems desirable to use other poisons, Paris green can be substituted.

This should be used at the following rate:

Formula	Paris Green	1 lb.
	Fresh lime	3 lbs.
	Water	50 gals.

Paris green is quicker in its action upon the insects than arsenate of lead, but will not remain as long upon the trees. Unless the lime is added, there is danger of "burning" the leaves. Lime is not needed with arsenate of lead.

The cost of spraying elm trees will vary from ten cents each in case of small trees to five dollars or more for the largest trees, according to the price of labor and the efficiency of the outfit.

Destroying the pupæ. If the trees have not been protected by spraying, and have been attacked and injured by a horde of beetles and their larvæ, it is always advisable to destroy the insects in the pupa stage at the base of the trees, in order to reduce the crop for next year as much as possible. These can often be swept up in large quantities; they can be killed by sprinkling them with hot water; but best of all is to spray the ground not only close to the tree but as far away as the branches reach, and also spray the bark of the trunk and large branches, with kerosene emulsion or some other contact insecticide. The pupæ are easy to kill, but as they remain in the pupa stage only about ten days, it is essential that this work be done at the right time, and it is only when we observe that most of the larvæ descending the trunk have transformed to bright yellow pupæ that we can know when is the proper time to act.

Destroying the adult beetles. The beetles should of course be destroyed in attics, belfries and other places where they hibernate. This can best be done by sweeping them up before

they become very active in spring and dropping them into the fire, hot water or kerosene to kill them.

OUTFIT FOR SPRAYING ELM TREES.

The barrel hand-power pump can be used for spraying small trees or for a limited number of large trees, but if one expects to make a business of spraying street trees, it will pay to procure a power sprayer; this may be a steam or gasoline engine with pump; and still another kind is the "Niagara Gas Sprayer," which utilizes cylinders of carbonic acid gas to furnish pressure, thus doing away with a pump. Each large village and city should have at least one power sprayer that can be put to immediate use for spraying street or park trees. Strong one-half inch hose should be provided in long lines of from fifty to two hundred feet, and from four to six of these can be attached to each power sprayer. Even a larger number might be attached, but while in operation some workmen would be in the way of others, so that nothing would be gained. Mr. H. L. Frost of Boston, who is in the spraying business, informed the writer that four lines of hose is about the most economical number for each outfit. Each hose is furnished with an extension rod with closing valve at the lower end and a cluster of nozzles at the upper end. These rods should be of different lengths, from four to twelve or fourteen feet for the different kinds of work. Any of the standard nozzles such as "Vermorel," "Mistry," or "Spraymotor" will be found satisfactory, and if several are used together in a cluster one is able to cover more leaf surface in a given time.

For getting about in tall trees it will be necessary for the men to be provided with climbing irons and extension ladders.

On account of the serious condition of the trees throughout the state, and the many inquiries and misleading letters in the newspapers from individuals, the following statement was given to the press in July:

Many elm trees in various portions of the city have lost nearly all their leaves from the attacks of the elm leaf beetle. The injured leaves have been dropping for several days, and the trouble has been aggravated by the extreme drought. Had it

been a wet season, many of the beetles would probably have been killed by the fungous disease which attacks them.

The damage has nearly all been done for this season, as the partial second brood is usually of little account. The larvæ or grubs are now crawling down the trees to transform to pupæ at the base. Many property owners have placed bands of sticky fly paper around their trees and have caught some of the larvæ, but most of them are prevented from coming down and will transform above the bands. It is probably better to let them descend where they can be reached easily and killed.

The bright yellow pupæ at the base of the tree and lodged in the crevices of the bark should be destroyed at once. This can be done easily by spraying them with kerosene emulsion or common laundry soap dissolved in water at the rate of one pound in eight gallons. They can also be swept up and burned or dropped into a pail of kerosene or of hot water.

Prompt action is necessary, for the pupa stage lasts only ten days, when the beetles appear and fly away. They do but little feeding, and go early into barns, attics and church belfries, where they pass the winter. The beetles can sometimes be gathered in large numbers and should always be destroyed.

Trees which have lost their leaves this season should be sprayed with poison (three pounds lead arsenate in fifty gallons of water) next year to preserve the foliage, for if completely defoliated for two or three seasons successively the trees will die. The poison should be applied in the form of a spray directed against the under surface of the leaves, where the larvæ or grubs feed.

People always become excited and wish to "save the trees" at this time of the year, after the damage has been done for the season. They should begin earlier, and spray the trees in time to prevent the injury.

WHAT TO DO.

1. Destroy all of the bright yellow pupæ at the base of the tree and in the crevices of the bark.

2. Hunt for beetles in houses, barns, attics, church belfries, and out-buildings during the fall, winter, and early spring, and destroy them.

3. Arrange to spray the trees with poison next year.

Information concerning this pest may be obtained at any time from the Connecticut Agricultural Experiment Station at New Haven. Bulletin 155 gives a complete account of the insect, and will be sent on request as long as the supply lasts.

W. E. Britton,
State Entomologist.

SUMMARY.

The elm leaf beetle was introduced into this country from Europe about seventy years ago, and caused serious injury to trees at Baltimore, Md., in 1838 and 1839. From this point it spread slowly, chiefly to the northward, reaching Connecticut in the early nineties, and injuring and killing many fine old trees in the coast towns. Later, inland towns were attacked, and the trees ravaged. The insect is now found from Charlotte, N. C., as far north as North Conway, N. H., and as far west as central Kentucky, but has not proven destructive to elm trees north of Massachusetts. It is preëminently a pest of shade trees in cities and towns, and seldom injures trees in the open fields. Since 1896 the attacks have diminished, but the pest was again serious in 1906.

The winter is passed by the adult beetles in attics, belfries and cracks in fences, and they come forth in April, and later feed and lay their yellow eggs upon the unfolding leaves. Beetles eat holes through the leaves, eggs hatch in a week, and the larvæ eat off the green tissue from the under surface, causing the leaves to turn brown and fall about the middle of July, at which time the larvæ are about full grown. Then they descend to the base of the tree and transform to naked pupæ; ten days later the adult beetles emerge and lay eggs for the second brood or go early into winter quarters.

Two complete defoliations in succession will kill a tree.

How to Fight the Elm Leaf Beetle.

1. Search all attics, church belfries and cupolas for the dormant beetles in winter and early spring. Sweep them up and burn them.

2. Spray the leaves with poison as soon as they have opened, if their shot-hole appearance shows that the beetles are there in abundance, and the under sides of the leaves should be coated about June 1st to destroy the larvæ or grubs.

3. When, later in the season, the yellow pupæ appear on the trunks of trees and the ground beneath, kill them with a spray of kerosene emulsion or by sweeping them up and burning or soaking with kerosene.

The first and third measures should be taken by each householder, church or social organization, at individual expense. The spraying, which is difficult and expensive if the trees are large, can only be done by concerted action of the town or borough authorities. For extensive spraying work power sprayers are desirable, but small elms or a few large trees can be treated successfully by means of a hand-pump of barrel size. The "Niagara gas sprayer" in operation is shown on Plate LVI.

THE GREEN CLOVER WORM A PEST OF BEANS.

Plathypena scabra Fabr.

Late in June the writer noticed that the bush and pole beans in his garden were being eaten by some insect, and during the first half of July complaints were received from five or six different persons who reported that their beans were being devoured. These complaints were mostly from around New Haven, but included one from Meriden. Similar injury to beans was observed upon the station grounds, and in several gardens, and was reported from the eastern portion of Massachusetts and from Virginia.

Though in the South there are several insects feeding upon the plant, it is quite unusual for beans in Connecticut to be attacked by any leaf-eating insect that noticeably defoliates them, and at first we supposed this pest to be *Ogdoconta cinereola* Guen., which Chittenden mentions* as a green striped caterpillar which feeds upon bean leaves.

Identity Established.

From a lot of caterpillars placed in breeding cages on July 14th, some of which began at once to pupate, about twenty

* Insects Injurious to Vegetables, p. 113.

specimens were raised, all of which proved to be *Plathypena scabra* Fabr., one of the commonest of our deltoid moths, usually known as snout-moths. No other species were reared from this material, so the evidence is conclusive that *P. scabra,* which is called the green clover worm, is responsible for the damage. After rearing the adults, the writer corresponded with Dr. Chittenden, who kindly called attention to his published article* on this insect, which up to that time had escaped the writer's notice. From this article are taken some of the facts herein set forth which were not observed by the writer.

Injury to Beans and other Food Plants.

Both common beans and Lima beans were attacked and the leaves more or less riddled with irregular-shaped holes. In the worst cases only the veins were left, and the pods were eaten in some instances. The caterpillars were usually found on the under side of the leaves, and on being disturbed the small ones would descend from silken threads, while the larger caterpillars would drop to the ground, wriggling violently and throwing themselves about. Different sized caterpillars were feeding at the same time, some being about full grown and others not more than one-third grown.

By the middle of July, after receiving the complaints and making observations, it was rather difficult to find an abundance of caterpillars, most of them having pupated, though evidences of their work remained. In one garden peas were devoured, and according to Chittenden† other food plants are clover, soy beans, tickweed (*Meibomia sp.*), vetch, strawberry and blackberry. Clover is considered as the usual food plant, but almost any species of the Leguminosæ may serve as food.

Life History.

A nice lot of material was brought to the laboratory on July 14th and was placed in breeding cages in the insectary. One caterpillar pupated in the box, and was not transferred to the breeding cage. On July 24th the adult emerged from this cocoon.

* The Green Clover Worm, Bulletin 30, Bur. of Entomology, U. S. Dept. of Agriculture, p. 45, 1901.

† *Idem.*

Another specimen emerged July 29th from a cocoon formed July 16th. Thus from ten to fourteen days are passed in the pupa stage. According to literature the eggs require from four to six days for hatching, and the larval stage occupies about twenty-five days. Chittenden finds three generations of this species in the latitude of the District of Columbia, though Coquillett found only two broods in Illinois. The moths do not appear with any particular regularity, as they are found throughout the latter part of the summer, specimens in the station collection bearing dates ranging from June to November.

Description.

Egg. The eggs of this species were not observed by the writer. Though adults were kept in the breeding cages with fresh material of the food plants, all died without laying eggs. Chittenden quotes* Coquillett's description in stating that they are globular and flattened, with the upper half deeply grooved and light in color. The average measurements showed them to be 0.5 mm. in diameter and 0.35 mm. in height.

Larva. About 25 mm. (one inch) long when fully grown, about 3mm. thick in thickest portion near middle, from which it tapers slightly toward the head and considerably toward the posterior extremity. Color light green, striped longitudinally with darker green and fine white or cream-colored lines. Head pale green, shining and hairy. Thoracic legs of the same color as the head. Three pairs of abdominal pro-legs in addition to the anal pro-legs. Each segment bears dorsally, ventrally and laterally a number of dark hairs.

The description just given is of the caterpillar in next to the last stage. In the last stage it is not striped, but nearly uniform in color, paler green and stouter than in the preceding stage. The larva loops in crawling, like the cabbage looper, but it is much more slender, and is not likely to be mistaken for that species.

Pupa. The first pupa obtained was formed in a pasteboard box, and was enclosed in a white silken web or cocoon of rather loose texture. Some larvæ pupated in a rolled leaf, though others went into the ground just beneath the surface and formed earthen cells by fastening together particles of earth with silk threads.

* Bulletin 30, Bur. of Entomology, U. S. Dept. of Agriculture, p. 45, 1901.

The naked pupa is dark brown in color, about 12 mm. (one-half inch) long and 3 mm. thick. A dorsal ridge extends from the head over the thorax and first four segments of the abdomen.

Adult. The moth has a wing expanse of from one to one and one-half inches, and in general is a dark purplish brown color with the fore wings more or less distinctly mottled with bluish gray, brown and black. The rear wings are very broad,

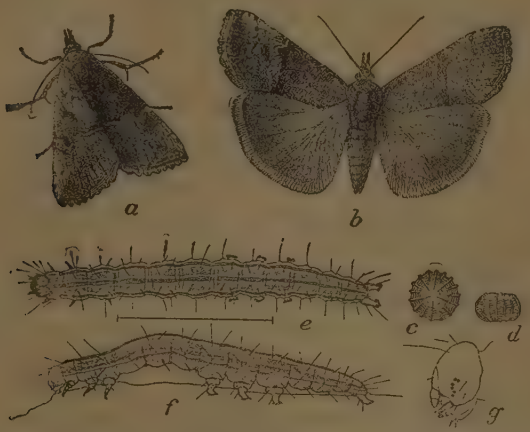


FIG. 18. The green clover worm: *a*, moth in natural position with wings folded; *b*, same with wings expanded; *c*, egg from above; *d*, side view of egg; *e*, penultimate stage of larva, dorsal view; *f*, same from side; *g*, head of larva. All enlarged. (After Chittenden, Bulletin 30, Bureau of Entomology, U. S. Department of Agriculture.)

smoky brown, and without markings. It is an extremely variable species, some specimens, especially males, being nearly uniform in color, while others, usually females, show very distinct markings. Ordinarily the females have somewhat less than half of the apical portion of the front edge of the fore wing marked with light bluish gray. Basally this extends across the wing in some cases, but apically it is limited by a blackish or brownish, more or less suffused mark, which extends diagonally from the apex of the fore wing, becoming less distinct toward the point where the base of the gray patch meets the rear margin of the wing.

The palpi are prominently elongated, and project in front of the head, as is the case with other members of this group, which on account of it are called snout-moths. They are called deltoid moths on account of the distinct triangular shape which they assume when at rest with wings folded.

The appearance of all stages of this insect is shown in Figure 18 on p. 831 and on Plate LVII of this Report. A technical description of the adult has been published by Professor J. B. Smith* with synonymy.

Remedies.

It is to be regretted that experiments were not conducted with different insecticides, but at the time of the complaints most of the damage had been done, and the larvæ had disappeared.

In case of Lima and other "shell" beans, the plants could be sprayed with lead arsenate, but any poison would be out of the question on string or snap beans, where it may be possible to apply air-slaked lime or some other fine powder by means of a blow-gun to suffocate the larvæ. From their habit of dropping when disturbed the writer has suggested that the vines be brushed or shaken and the larvæ caught in a dish of kerosene or killed upon the ground. No doubt a good spraying of the under side of the leaves with strong soap and water would kill many of the caterpillars, especially the smaller ones.

Usually this insect feeds upon clover, and the damage is so slight that no remedial treatment is necessary.

TREATMENT OF CABBAGE PLANTS TO PREVENT INJURY BY THE CABBAGE MAGGOT.

By W. E. Britton and B. H. Walden.

Mount Carmel Experiments.

In the Report of this station for 1906, page 301, there was published a note about dipping plants in a mixture of lead arsenate to prevent injury by the cabbage maggot, *Pegomyia brassicæ* Bouché. This practice was continued in 1907, but in both these

* Revision of the Deltoid Moths, Bulletin 48, U. S. National Museum, p. 111, 1895.

years the insect was so scarce that very little harm was done to the plants by it, consequently the experiments failed to show anything.

In the spring of 1908, tests of various substances and devices were made on the grounds of Mr. Howard C. Yale at Mount Carmel, where the crop had been troubled each season for several years by the maggot. The tests were made on thirteen rows of plants, each row containing about one hundred and thirty-five plants. The rows extended in a northerly and southerly direction, and at the north end the ground was four or five feet higher than at the opposite end of the field.

Rows 1 and 2 were set April 18th, and the plants dipped in lead arsenate (one pound in two gallons of water), Jersey Wakefield in Row 1 and Henderson's Summer in Row 2. Rows 3 to 8 were set about a week later, and Rows 9 to 12 still later, with untreated plants of these varieties.

On May 14th, Rows 3 and 4 were treated with carbon disulphide. A hole at least an inch deep was made near each plant and from one-third to one-half a teaspoonful of the volatile liquid was injected from an oil can and covered up.

Row 5 was left as a check.

Row 6. On May 4th tarred paper disks were placed around a portion (about one hundred) of the plants, beginning at the north end of the row. These disks were a year old and had become dry and stiff, and consequently did not fit as well around the stem nor as close to the ground as when fresh. On May 6th, placed fresh disks on the remaining plants in Row 6 and on the plants in Row 7. These disks were cut with a knife from a single-ply tarred paper.

Row 8, beginning at the north end, seventy-four plants were treated May 6th with the lime-carbolic mixture, made by slaking fresh quicklime, and one quart of the thick cream added to one gallon of water. To this was added about one teaspoonful of crude carbolic acid, as used by Professor J. B. Smith* of New Jersey. The mixture was then sprayed upon the soil around each plant in a circle six to eight inches in diameter.

On May 16th, all of the plants in Rows 8 and 9 were sprayed with the lime-carbolic mixture. Used eight ounces of lime to one

* Bulletin 200, New Jersey Agr. Expt. Station, p. 18, 1907.

gallon of water and 15 c.c. of crude carbolic acid. On this date we were not able to detect any signs of the work of the maggot.

Rows 9, 10, 11 and 12 were treated with salt on May 30th by the owner, nearly a teaspoonful to each plant being placed around the stem at hoeing time. This treatment was evidently too late, as the maggot had already begun its work on some of the plants in the other rows before this date.

Mr. Walden visited the field May 28th and examined the plants. A few were beginning to wilt from the attacks of the maggot on rows treated with lead arsenate, carbon disulphide and carbolic-lime mixture. On digging, maggots were found at the base of most of these wilted plants. The two rows treated with the tarred paper disks looked the best of any and showed no indication of the presence of maggots.

On May 29th and 30th, carbon disulphide was injected around each of the plants in the two rows which at setting had been dipped in lead arsenate, and likewise in the two rows treated earlier with carbon disulphide. This time a hole about one inch in diameter and three inches from the stem, slanting toward the root, was made with a pointed stick, and the liquid was injected through an oil can, using one pound to one hundred plants, or about one-sixth of an ounce per plant.

On June 6th, Mr. Walden visited the field and made a record of the infested plants. Rows 1 to 5 contained from two to nine infested plants per row, the first four rows each having more than the check (Row 5). Row 8 had four infested plants. Row 6 had none and Row 7 had but one. These two rows were treated with the tarred paper disks. Rows 9 to 12 showed no infestation, but as they were not set out until considerably later than the others, it is doubtful if the result should be attributed to the application of salt, which was made too late to entirely keep away the maggots.

Another examination of the plants was made July 3d, and they were found to be in about the same condition as on June 6th, except that those plants which had wilted beyond recovery had been removed, some slightly injured plants had recovered and were beginning to head, and no additional plants showed the attacks of the insect. A few of the plants were well headed and ready to cut.

The plants were all cultivated and hoed about every ten days, and an application of commercial fertilizer with the addition of nitrate of soda was made at the time of each hoeing.

Branford Experiments.

In the raspberry field of A. E. Plant & Son, Branford, cabbage plants were set between the rows of berries during April, without treatment. The field was on a side hill sloping to the south and west. The rows used in the experiments were on the upper side, and extended north and south. The soil was rather heavy except at the north end of the rows.

On May 12th treatment was given as follows:

Rows 1 and 2 were left as checks, no treatment.

Rows 3 and 4, containing ninety-nine and one hundred and ten plants respectively, were supplied with tarred paper disks.

Row 5, check, no treatment.

Row 6, ninety-one plants, Row 7, ninety-four plants, and Row 8, ninety-nine plants, were treated with carbon disulphide applied through an oil can in a hole an inch from the plant and one and one-half inches deep. After the material was introduced into the hole, it was covered with soil by the foot. One pound of the liquid was used for the three rows.

The plants were examined on June 5th. and only two plants infested with the maggot were found, one in a check row and the other in a row treated with carbon disulphide.

Value of Tarred Paper Disks.

Tarred paper disks and a tool for cutting them were first devised by Professor E. S. Goff of Wisconsin, and have since been used by Slingerland and others. They prevent (mechanically) the flies from laying their eggs at the base of the stem, and where made of tarred paper it is possible that the odor may have a repellent effect, though this is not certain.

In our tests these disks have given the best results of any form of treatment, and similar results have been obtained by other entomologists. It is important that they be applied before the eggs are laid, otherwise they are ineffective. Plants which have become badly injured by the maggot should be destroyed, those

slightly damaged should be treated with carbon disulphide as herein described, and well fertilized to promote growth and vigor.

Making the Paper Disks.

During the previous season the tarred paper disks could be purchased from a New York firm, but this season we were unable

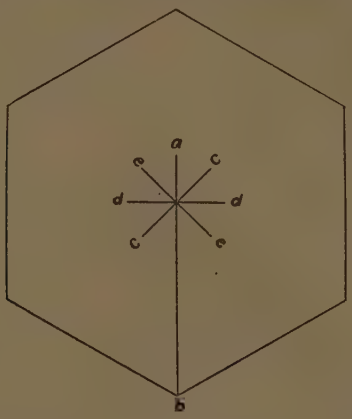


Fig. 19. Hexagonal disk of tarred paper for use on stems of cabbage plants.

to obtain them. We did not have a special tool for cutting them, so they were made in the following manner:

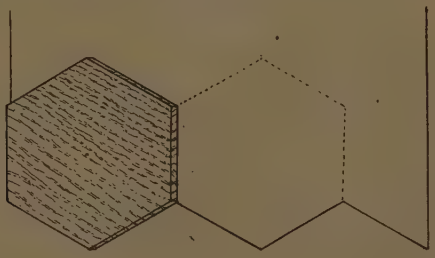


Fig. 20. Method of cutting hexagonal disks.

The disks were hexagonal in shape and four inches across, and were cut from a roll of single-ply tarred felt or paper. The paper was placed on a table and unrolled upon a smooth board as

needed. A hexagonal form was made of wood one-quarter inch thick, with a tack through the center to prevent the form from slipping and to mark the center of each disk. The form being placed on the paper, a sharp knife was used to cut around it. A row of disks were cut from the full width of the paper and then stacked together, when the cut *a-b* (Figure 19) was made with the knife; *c, d* and *e* were made with a sharp chisel, which in this case was 1⅛ inches wide. After the first row has been cut, the paper will have an edge with regular points, which should be used to form two sides of the next row of disks.

Figure 20 shows the form placed to start another row of disks, and the dotted lines show that but three cuts are required to make each succeeding disk.

While this method would not be practicable for a large commercial grower, it will answer where but a few thousand disks are needed. They can be made at odd times during the winter and early spring. If made much in advance of the time when needed, however, they should be tightly wrapped and kept in a rather moist place so that the tar will not dry out and the disks become hard.

EXPERIENCES WITH HOME-MADE SOLUBLE OILS AND SOME OTHER SPRAY MIXTURES.

By W. E. Britton and B. H. Walden.

Probably the most important development in spraying for San José scale in 1907 was the working out of formulas for the preparation of home-made soluble or miscible oils, so that the orchardist can make them on his own place.

Professor Charles L. Penny, now of the Pennsylvania Station, but formerly chemist of the Delaware Station, has done much investigating along this line, and the results of his efforts were published in Bulletins No. 75 (June 18, 1906) and No. 79 (August 1, 1907) of the Delaware Station.

Mr. C. D. Jarvis, horticulturist of the Storrs (Conn.) Station, had also been working on soluble oils, and in Bulletin 49 (November, 1907) recommends a formula which he found best for general purposes.

The bulletins by Professor Penny explain the principles of making these mixtures and the rôle played by each of the

ingredients, chiefly from the chemical standpoint. A large number of formulas are given, thus showing the possibilities of the subject, though one is recommended as being the best for the average orchardist to use. The bulletin by Mr. Jarvis gives brief directions to the orchardist about procuring materials and preparing the mixtures after a single formula, which is quite similar to the one recommended by Professor Penny, containing the same ingredients in only very slightly different proportions, except that the former contains crude oil where the latter has paraffine oil.

As many inquiries were made at this station regarding these mixtures, it was deemed best to make a practical trial of preparing and using them so that we might more intelligently answer the inquiries. Therefore, a kettle or feed cooker was purchased, and the materials were procured in barrel lots, consisting of carbolic acid, menhaden or fish oil, rosin oil, crude petroleum, paraffine oil, kerosene, and a small quantity of caustic potash. The first cost of these materials was nearly one hundred dollars, and of course some of them will last for a long time. The outfit is shown on Plate LVIII b. We had no particular trouble in making up the first lot according to directions, and care had been taken to purchase only the grade of materials recommended. But on using up the first barrel of paraffine oil, we ordered a second barrel of exactly the same oil, and it failed to emulsify as the other had done when used in the same quantities with the other ingredients. It was then necessary to try varying proportions of some of them, and Mr. Walden worked on it two whole days before we could use it in making a spraying mixture. A different grade of oil had been sold us for the same oil, and it required considerable experience to learn how to use it. Oil experts have informed us that the common trade names of oils are meaningless so far as their exact chemical composition is concerned, and that there is little assurance of being able to obtain the same thing twice unless it comes from the same well and is drawn at about the same time. It seems to us that the first cost of the materials, together with the uncertainty of obtaining uniform oils, make it impracticable for any except the larger orchardists to prepare their own soluble oils.

Orchard tests were also made. All fruit trees on the station grounds were sprayed January 23d. The mixture worked nicely, except that a thickened oily residue formed in the pump barrel and

caused some trouble in clogging strainers and nozzles. This may have been due to an excess of rosin oil. The scale was kept well in check by the application, and no injury to the trees was noticed. Two barrels of this mixture, one made from crude and the other from paraffine oil, were furnished to Mr. F. H. Stadtmueller of Elmwood, who used it in April on rather large apple trees, applying it with a steam power sprayer. The residue was present in the tank, though not especially troublesome. The mixture was apparently effective in checking the scale and the owners were satisfied with the treatment.

A barrel of this mixture was used in the young apple orchard of A. E. Plant & Son of Branford, the spraying being done April 20th. An examination of this orchard December 10th showed that the trees are in good condition, and though most of them were only slightly infested at the time of treatment, it is now a difficult matter to find any living scales. Two or three trees which were badly infested two years ago showed but little live scale at this time.

Two barrels of the mixture made from crude oil were used in the apple and peach orchards of Mr. W. F. Griswold at Rocky Hill, in April. Mr. Griswold reported considerable trouble in using the material, and it did not seem to be very effective in holding the scale in check. Mr. Walden visited the orchard on December 2d and found the sprayed trees fully as scaly as those which were not treated. It is hard to explain why the treatment here was not more effective.

The trees on the station grounds were again sprayed with this material December 8th and 9th, 1908, and it worked satisfactorily, though the effect upon the trees and their scale insects cannot at this date be determined.

In all of the tests just mentioned the oil was mixed with water in the proportions of one part of oil to fifteen parts of water.

The cost of the materials actually used in making this home-made soluble oil was about twenty-one cents per gallon, not reckoning labor, the cost of the kettle, or interest on the money invested. Of course the cost would vary according to the fluctuating prices of the materials used.

This oil is now made by the Apothecaries Hall Company of Waterbury, and sold as "Victor Soluble Oil," in barrel lots, at thirty-five cents per gallon. It is also made by the J. T.

Robertson Company of Manchester, Conn., and sold as "Jarvis Spray Mixture" at thirty cents per gallon by the barrel.

Other Oils Tried.

A five-gallon can of the soluble oil made by the Thomsen Chemical Company of Baltimore, Md., was used in the Plant orchard at Branford. It worked satisfactorily and the trees were clean in the fall.

"San-U-Zay" scale oil, made by J. T. Southwick of Rochester, N. Y., was also given a trial. This oil requires a solution of sal soda to make it emulsify, but it seemed to work nicely, and, like the preceding, kept the trees clean. Both of these oils were used in the same proportions as the home-made oils mentioned above.

Another kind of oil was sent us by Professor H. W. Hillyer of Farmington. This came in two parts; one, marked "B," was the oil preparation, and the other, marked "A," contained the emulsifier, together with a copper solution which was supposed to make it a fungicide. This was also used one part to fifteen parts of water, and four small scale-infested apple trees were thoroughly sprayed with it. When examined the first week in July, about twenty-five per cent. of the scales were alive. It is evident that this mixture should have been used in more concentrated form.

New Prepared Lime and Sulphur Washes.

Since our work with the lime and sulphur mixtures a few years ago (see Reports for 1903, p. 233; 1904, p. 221; 1905, p. 196; and 1906, p. 279) several prepared lime and sulphur washes have been placed upon the market. Some of these we have tested and a few gave good results, but most of them contained so much sediment that they did not spray readily, failed to destroy the scale, or else were so costly as to be prohibitive.

Recently there have been put upon the market a number of prepared lime and sulphur washes which are clear liquids, that is, entirely soluble, and contain no sediment to clog strainers and nozzles. Some of these are being sold at a price low enough so that orchardists are buying them to spray orchards of several thousand trees.

Three of these mixtures, in small quantities, have been tested by us:

"Lion Brand California Wash," a concentrated lime, sulphur and salt mixture, made by the James A. Blanchard Company of New York. On April 19th four small apple trees were thoroughly sprayed with this mixture, following directions. The first week in July the trees were examined, and only 3.8 per cent. of the insects found to be alive.

"Swift's Concentrated Sulphur-Lime," made by the Merrimac Chemical Company of Boston, and "Sulfocide," made by the B. G. Pratt Company of New York, have each been tried on a few trees, but it is now too early to be certain of the results.

Of course these preparations must be tested on a large scale and under varying conditions before we can recommend them, but there still seems to be a demand for lime-sulphur washes, and if they can be made cheaply and satisfactorily, most of the smaller growers will prefer to purchase the prepared mixture.

Conclusions.

Our own experience in making soluble oils leads us to advise orchardists to purchase a prepared mixture, except that in some cases a large grower might find it profitable to buy the materials and make it at home. Materials left over will keep for a time, but do not improve, and some loss takes place through leakage and evaporation. It is also certain that where made in large quantities the product will run more uniform than it is possible to make it in small quantities, even with great care.

It is not claimed that any of these home-made oils are better than the best kinds on the market—they are simply cheaper and can be used for the purpose.

It is probable that soluble oils will continue to be used for spraying apple orchards, especially large trees, where it is difficult to coat the pubescent twigs with a lime-sulphur wash, and to reach the scale insects under the edges of the rough bark and the bud scales. They are also much to be preferred for use in the city garden, the public park and the nursery.

On the other hand, soluble oils have not entirely superseded lime-sulphur. Several orchardists have continued using the latter, and some others are going back to it. The lime-sulphur wash

is certainly an effective scale destroyer on smooth-barked trees, and no better treatment is known for the peach orchard than to spray it in the spring with the lime-sulphur wash, which is an excellent fungicide and a good preventive of leaf-curl.

INSECT NOTES.

Snow-White Linden Moth Abundant. On July 8th the Associated Press and several New Haven newspapers telephoned to the entomologist's office regarding the reported occurrence of the brown-tail moth in Woodstock, where some newspaper correspondent had reported it as being abundant and swarming around the street lights. Through telephone and written communication with several reliable men in that part of the state, including Mr. L. H. Healey, Master of the State Grange, this report could not be verified and specimens could not be obtained.

A few days later the New York papers told about a pure white moth that swarmed about the electric lights in New York and Brooklyn. On July 19th a similar swarm of white moths appeared in New Haven, and the description was a feature of the newspapers the following day. These moths were present for about two days, then disappeared, but were very abundant while they lasted, and may be the same species as that reported from Woodstock. This moth is called the snow-white linden moth (*Ennomos subsignarius* Hübn.), and in some books is mentioned under the name of elm span worm. It feeds upon a variety of forest and shade trees, and is reported as causing much damage to beech trees in New York State in 1907,* though linden, elm, maple, chestnut and horse chestnut are often damaged.

This moth is pure white, has a wing expanse of about one and one-half inches and is shown on Plate LIX a. It is frail, with angulated wings, and belongs to the moth family Geometridæ, the larvæ of which are measuring worms or loopers. There is one generation each year, and both sexes have wings. Spraying the foliage with arsenical poison is about the only remedy.

Hickory Tussock Caterpillars Killed by a Fungus. In the Report for 1907 there is a short article about the hickory tussock

* Twenty-third Report of N. Y. State Entomologist for 1907, p. 23.

moth, *Halisidota caryæ* Harris, and its abundance in Connecticut during the past two years. It was also very abundant in the summer of 1908 and did some damage to various kinds of trees, but in September and October many dead caterpillars were observed adhering to the trunks and branches of trees and sometimes on fences and stone walls. These had been killed by a fungus which, according to Dr. Clinton, has been studied and named in manuscript by Professor Roland Thaxter of Harvard University, but the description and name have not yet been published. From the number of dead caterpillars seen while inspecting nurseries about the state, this fungus must be regarded as an important natural enemy of the species. In some cases a dozen of these dead caterpillars would be found on the base of the trunk of a single tree, and there were probably many more on the branches. The appearance of a fungus-killed caterpillar may be seen on Plate LIX b. Other species of caterpillars, notably *H. tessellaris* and probably *Estigmene acræa,* were killed in a similar manner by this or some other agency, though only a few of them were found.

Lead Arsenate vs. Paris Green for Spraying Potatoes. In the experimental field at Mt. Carmel, Doctors Clinton and East of this station have each year grown three or more acres of potatoes. During 1908 they made arrangements with the writer to take charge of the first sprayings to kill the Colorado beetle, before it was time to use Bordeaux mixture. Little damage was done, so the first treatment was given June 22d. On two plats of one acre each on the northwest corner of the field, conditions were practically uniform as regards the plants and their infestation. Here and there throughout, certain hills were badly eaten, though most of the plants had not been injured. The acre plat nearest the road was treated with Paris green, one-half pound in fifty gallons of water, and two pounds of lime added. The plat adjoining this on the east was sprayed the same day with lead arsenate, three pounds in fifty gallons of water. Both poisons were used upon the third acre. A hard shower came the next day. On June 27th, four days after the treatment, the potatoes were examined and the fewest larvæ were found on the field sprayed with lead arsenate, while no injury to the plants could be detected. Where Paris green was used, not only were the

larvæ more abundant, but in spite of the fact that plenty of lime was used, there was some injury to the plants, shown by many leaves and tips of leaves becoming dry and dead a few days after the treatment. The poison was applied with the Niagara gas sprayer, covering four rows at once, as shown on Plate LVIII a. This sprayer does not have a satisfactory arrangement for agitating the liquid, but in most other respects it is fairly satisfactory.

The Three-Lined Leaf-Beetle on Potatoes. This insect was more than usually abundant on potatoes and in some cases did almost as much injury as the Colorado beetle, to which it is closely related, both belonging to the family *Chrysomelidæ*. The three-lined leaf-beetle, *Lema trilineata* Oliv., is of a pale yellow color, with three black longitudinal stripes on the back, and it resembles the striped cucumber beetle, though larger. It deposits yellow eggs in rows along the mid-rib on the under sides of the leaves. The larvæ are yellow and have the disgusting habit of covering themselves with their own excrement. There are two broods each year. The damage is similar to that caused by the Colorado beetle and the same remedies are to be advised. Larvæ of the three-lined leaf beetle were brought to the station on July 12th, with two other kinds of beetles which had been observed feeding upon them in New Haven. The predaceous beetles were *Lebia grandis* Hentz. and *Pterostichus lucublandus* Say, both common species of the family *Carabidæ*.

Leaf-Beetles Devouring Marsh Golden-Rod. During a collecting trip to the Stratford marsh, July 21st, it was noticed that the golden-rod (*Solidago sempervirens*) which grows in bunches commonly about the marsh was being eaten up by insects. On closer examination, two forms of injury were apparent and caused by two different kinds of beetles of the family *Chrysomelidæ*. The larger, *Trirhabda canadensis* Kirby, is dull yellow, with three blackish longitudinal stripes, and is about three-eighths of an inch in length. It feeds upon this golden-rod in both the larval and adult stages, and the plants were stripped of their topmost leaves and tender shoots by this insect. The lower leaves were less injured and were still green. In other clumps the leaves were entirely brown, many of them being rolled and containing large numbers of a beetle known as *Microrophala vittata* Fabr. This

beetle is one-fourth of an inch long, with the entire upper surface of the body pitted and striped longitudinally with dull red and blue. The larvæ are said to be miners in the leaves of this golden-rod. As the host plant is something of a nuisance to growers of salt marsh hay, perhaps these insects may be regarded as beneficial.

Chrysomelid Beetle Damaging Young Chestnut Trees. On June 10th specimens were received from Dr. Robert T. Morris of New York, who raises nuts on his summer place at Stamford, Conn. Small metallic green beetles a trifle over one-eighth of an inch in length were devouring the leaves and young shoots of choice young chestnut trees of the Japanese species (*Castanea Japonica*), threatening their destruction. The beetles had the habit of dropping from the leaves or flying away when disturbed. It was finally necessary to resort to spraying with Paris green in order to destroy them. The species proved to be *Nodonota puncticollis* Say.

New York Weevil Injuring Pear. On May 26th it was reported that an insect was injuring young pear trees in the orchard of W. A. Henry & Son at Wallingford. Mr. Walden visited the orchard and found that the New York weevil, *Ithycerus noveboracensis* Först, was the depredator. The adults were eating into the twigs at the base of the new growth, in some cases nearly severing it. There were from one to three on each tree, and on some of the newly-set trees the new growth had all been destroyed. The injury was confined mostly to the pears, though one plum tree showed the attacks of this insect.

The New York weevil is a beetle of the family *Curculionidæ*, commonly called "snout beetles" because the head is prolonged forward into a beak or snout, on the end of which the mandibles or jaws are located. In color it is gray or slightly reddish, with whitish, closely appressed pubescence arranged in rows lengthwise the body. It is marked with a number of small quadrate black spots, is from one-half to five-eighths of an inch long, and is shown on Plate LIX c.

The owners sprayed the trees with lead arsenate, and thought that it proved effective, as the beetles soon disappeared. As a rule, the beetles of this family are hard to kill with poisons, and

hand picking is therefore advisable on small trees. Normally this beetle breeds in oak, beech and hickory twigs, and possibly visited the pear trees from the neighboring woodland. It has also been known to attack peach.

Snout Beetle Injuring Greenhouse Plants. On April 6th, beetles were received from Litchfield, where they had been eating the leaves of palms, lemon tree, *Tradescantia* and *Dracæna.* It proved to be *Otiorhyncus sulcatus* Fabr.

Strawberry Weevil. On June 3d specimens of the strawberry weevil, *Anthonomus signatus* Say were received from South Killingly and from Huntington, where at both places the stems of the buds and developing fruit had been eaten by the weevils. This insect is a snout beetle of the family *Curculionidæ,* and is less than one-eighth of an inch long and brown or black, with white markings.

The injury is caused by the female, which lays an egg in the bud just before it opens, then crawls down the pedicel and cuts it partly off, so that it fails to develop and later becomes separated and falls to the ground. The growing larva feeds upon the pollen inside of the bud, which after falling to the ground is kept moist and in a condition favorable to the development of the larvæ, which reach their full size in about three or four weeks.

The strawberry weevil when abundant is a difficult pest to control, and arsenical sprays are not very satisfactory. Pistillate varieties are not attacked, and growers are advised to grow only enough staminate plants for purposes of fertilization. Clean culture is also to be recommended.

Raspberry Sawfly. The raspberry sawfly, *Monophadnoides rubi* Harris, was present in a number of berry patches around New Haven, and was sent in from Stonington on July 8th. The larvæ are nearly three-quarters of an inch long when fully grown, dark green in color, and covered with lighter green forked spines. They devour the leaves of raspberry and blackberry, usually being found upon the upper surface. The eggs are white and are laid in the tissues of the leaf. The adult is a four-winged fly with a black thorax and dark reddish abdomen. Spraying with arsenites, or even with fresh hellebore, may be practiced as a remedy.

Leaf-Folder Injuring Apple. In many parts of the state apple trees were considerably damaged by a small larva which fed upon the leaves and folded and fastened the edges together. At Stonington this pest seemed to be more injurious than around New Haven. Though we did not obtain the adults, it was doubtless the apple leaf-folder, *Ancylus nubeculana* Clem., a small moth of the family *Tortricidæ*, having a wing-spread of about five-eighths of an inch, and brown and white in color. Ordinarily this insect is not troublesome, but was injurious enough at Stonington to warrant spraying. Lead arsenate is advisable for this.

Leopard Moth in Connecticut. This insect in its larval stage is one of the worst pests of shade trees in the vicinity of New York City, boring in the twigs and branches, the symptoms being dead limbs projecting above the leafy branches. The leopard moth, *Zeuzera pyrina* Fabr., was introduced probably by accident from Europe, and first noticed in this country near New York about 1882. Since then it has been spreading northward, but was not known to have reached Connecticut until July 1st, 1907, when Professor H. W. Foote captured in New Haven two specimens, which are now in the station collection. This insect is also serious in the vicinity of Boston. The adult has a wing expanse of about one and one-half inches, the wings being whitish or transparent, marked with a large number of small dark gray or black dots. The body is nearly black.

Infested branches will often wilt, and can be cut away and destroyed before the borers escape. Carbon disulphide may be injected into the burrows, and the opening stopped with clay, hard soap or putty, to kill the larvæ.

Appearance of Corn Ear-Worm or Boll-Worm, Heliothis obsoleta Fabr. Some larvæ and their work were brought to the station from Bethany on October 28th. The writer saw this insect in New Haven some twelve or thirteen years ago, but has never happened to see it since. The larva attacks corn, eating the unripe kernels at the tip of the ear, also tomato, cotton, and several other cultivated plants, though in the Northern States it is not a very serious pest. The adult is dull yellow, with dark markings, and the larva appears in a variety of colors, such as green, brown,

pink and purple. About the only preventive measure necessary is to plant the corn earlier, so that it will ripen before October.

Abundance of the Pyramidal Caterpillar, Pyrophila pyramidoides Guen. This caterpillar is about one and one-half inches long, green, with a yellowish stripe along each side and a whitish stripe along the back, head whitish, mandibles tipped with black. The last segment is thickened dorsally, making almost a right angle.

In the writer's garden these caterpillars fed upon the new leaves and shoots of the pear trees and also attacked roses. Specimens received from Warren on June 12th had been eating pear, rose and quince. They were also found on *Rosa rugosa* on the station grounds.

The adult is a noctuid moth having a wing expanse of nearly two inches. The front wings are dark brown marked with lines and dots of paler brown and white. The rear wings are lustrous and of copper red color.

A New Forest Pest in Northern New England. During the past two years the caterpillars of a moth, *Heterocampa guttivitta* Walk., have damaged forests in Maine, New Hampshire and New York. In 1907 in the state of Maine much of the forest growth over large areas for a distance of forty miles was stripped, according to Miss Edith M. Patch,* entomologist of the Maine Station. According to Dr. E. P. Felt,† state entomologist of New York, this same insect appeared in that state in 1907. The same species denuded thousands of acres of hard wood trees in the White Mountain region of New Hampshire in 1908, and Director E. D. Sanderson of the New Hampshire Station issued a press bulletin regarding the matter. It is during July and August that the defoliation becomes noticeable, and several different kinds of trees are attacked, though the caterpillars seem to prefer beech, maple and apple foliage.

* Bulletin 148, Maine Agr. Expt. Station, p. 262, 1907.
† Twenty-third Report of N. Y. State Entomologist for 1907, p. 21.

a.—Scraping apple trees.

b.—Spraying infested spruce trees with lead arsenate.

GYPSY MOTH WORK AT STONINGTON.

I. B.

a.—View in a back-yard after cutting and burning infested weeds.

b.—A clump of wild roses growing on this spot contained 275 caterpillars.

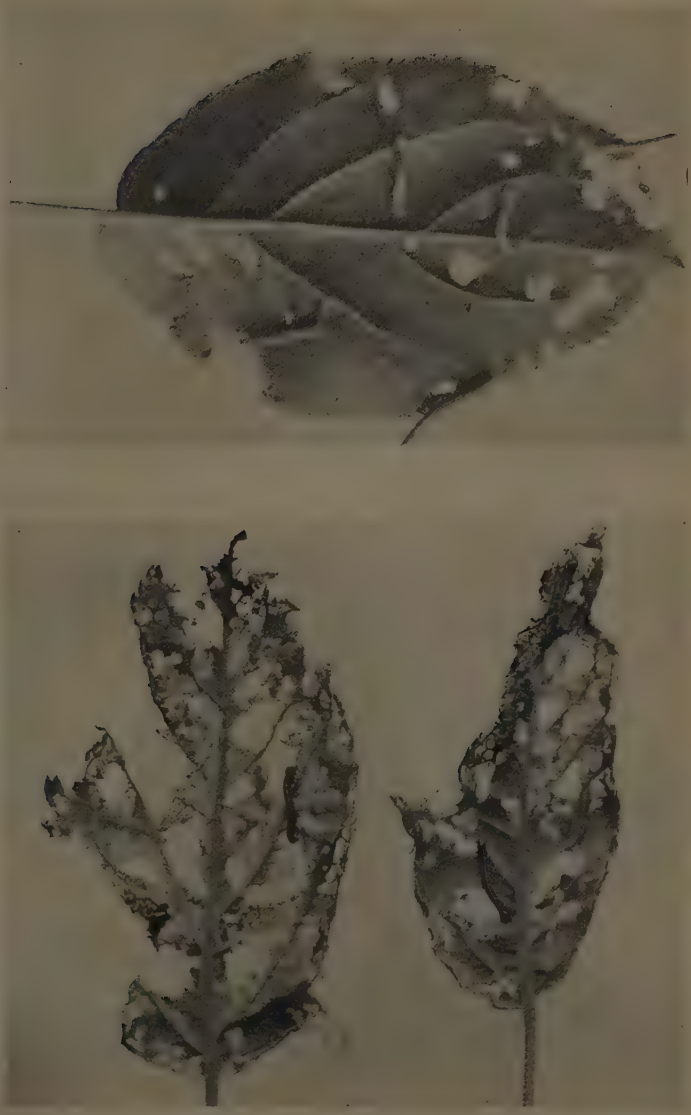
GYPSY MOTH WORK AT STONINGTON.

a.—Adult female and egg-mass of the fall canker-worm. Twice natural size.

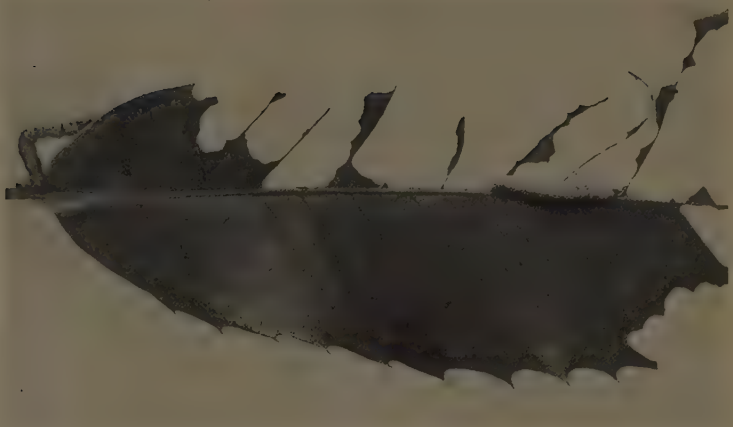
b.—Eggs of the spring canker-worm.
Twice natural size.

c.—Egg-masses of the fall canker-worm. Natural size at left, others twice natural size.

CANKER-WORMS.



FALL CANKER-WORMS FEEDING ON APPLE. Both natural size.



a.—Feeding upon chestnut. Natural size.

b.—Feeding upon elm. Natural size.

FALL CANKER-WORMS AND THEIR WORK.

a.—Adult males of the spring canker-worm.

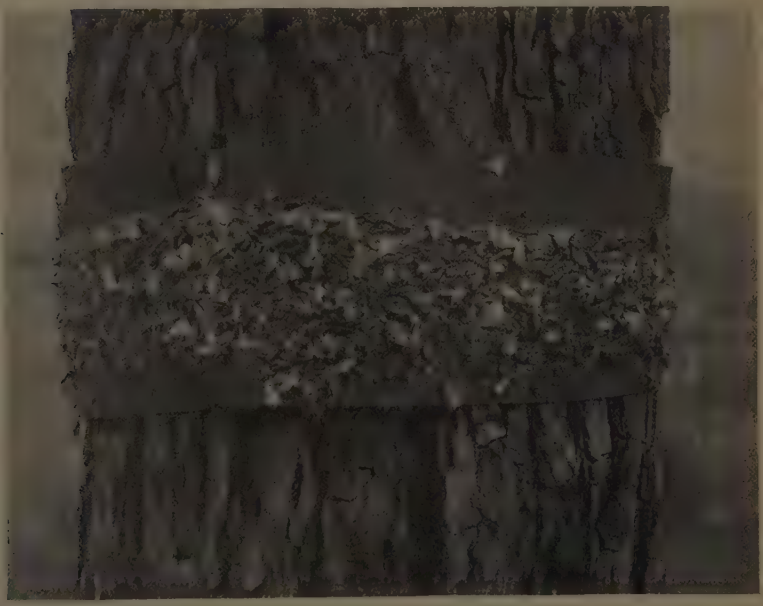
b—Adult males of the fall canker-worm.

MALE CANKER-WORM MOTHS. All natural size.

METHOD OF APPLYING STICKY BANDS TO PROTECT TREES FROM CANKER-WORMS.

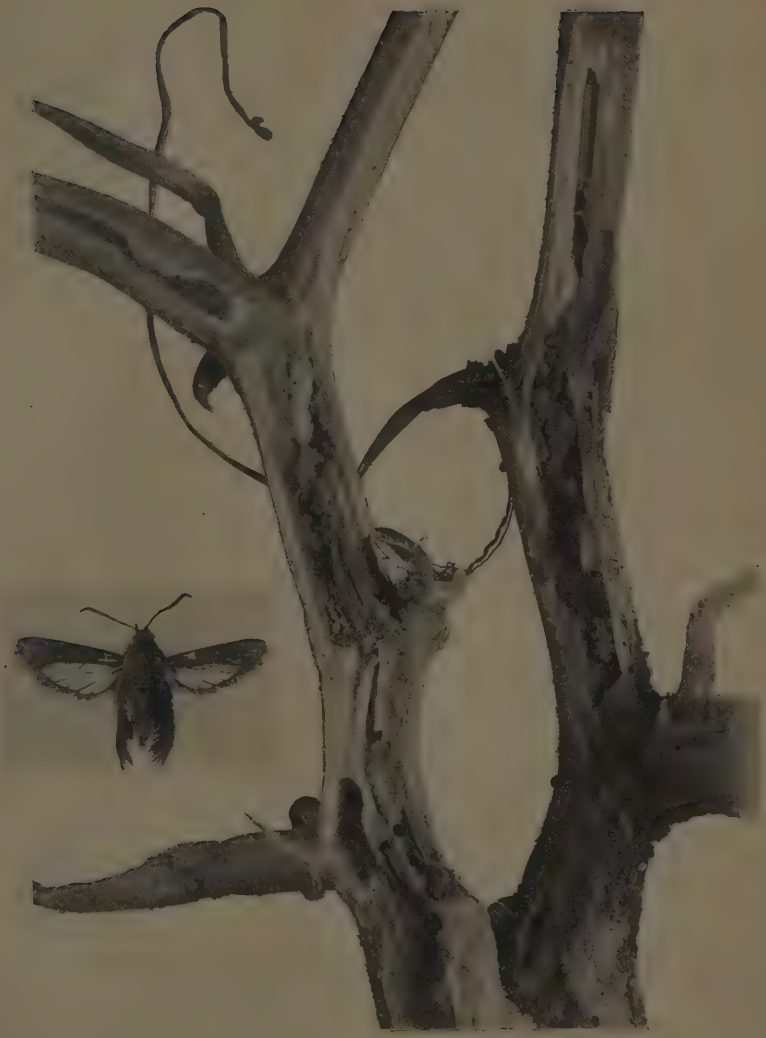
a.—Pupae of the spring canker-worm. Twice natural size.

b.—Cocoons and pupae of the fall canker-worm. Twice natural size.

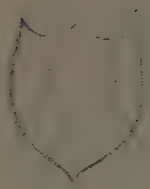


c.—Adult male and female moths, and egg-masses on sticky band.

CANKER-WORM COCOONS AND ADULTS.



SQUASH BORER: ADULT AND WORK OF LARVAE IN SQUASH STEMS.
Slightly enlarged.



CUCUMBER PLANTS INJURED BY THE LARVAE OF THE STRIPED BEETLE.
Natural size.

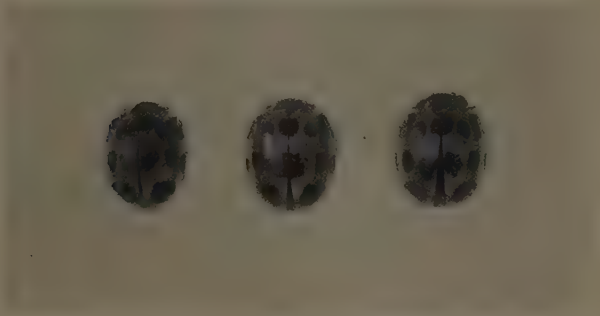
a.—Eggs and young squash bugs. All natural size.

b.—Work of the squash lady-beetle. Greatly reduced.

SQUASH BUG AND WORK OF SQUASH LADY-BEETLE.

a.—Twelve-spotted cucumber beetle. Enlarged four times.

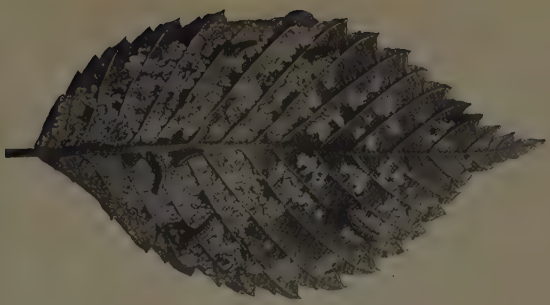
b.—Striped cucumber beetle. Enlarged four times.



c.—Squash lady-beetle. Twice natural size.

d.—Squash bug. Twice natural size.

SQUASH AND CUCUMBER BEETLES AND THE SQUASH BUG.

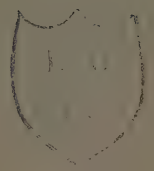


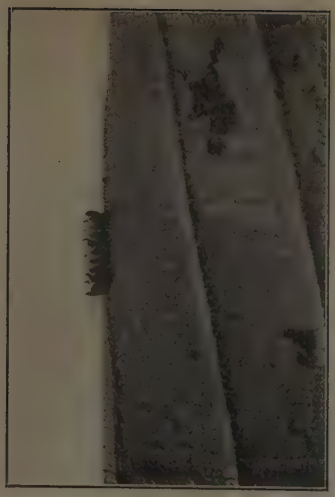
a.—Larvae and their work.

b.—Holes eaten by adult beetles.

c.—Adult beetles killed by the spined soldier bug.

WORK OF ELM LEAF-BEETLE. All natural size.



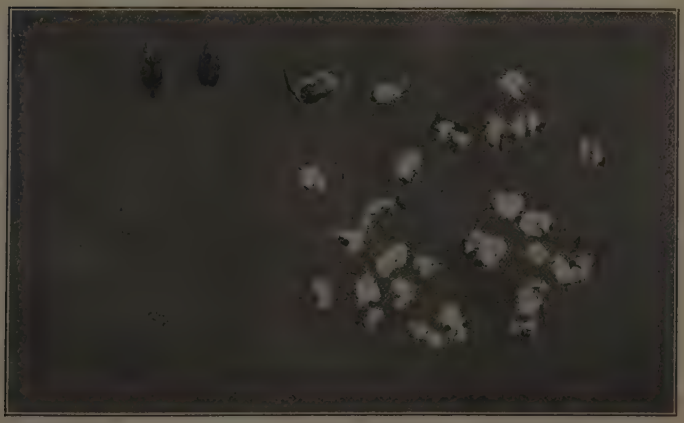


a.—Cluster of eggs; greatly enlarged.

b.—Larvae and pupae; twice natural size.

c.—Adult beetles; twice natural size.

d.—The spined soldier bug, *Podisus maculiventris*, Say. Twice natural size.

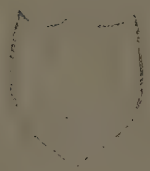


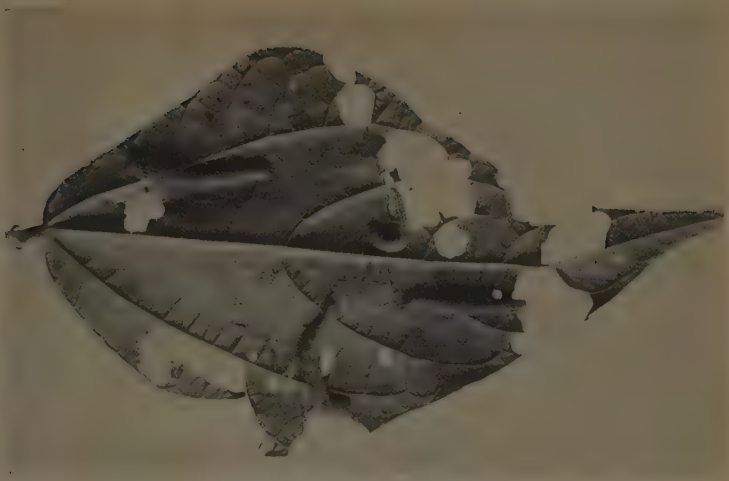
e.—Pupae and adults killed by fungus. Healthy specimens at the left, natural size.

THE ELM LEAF-BEETLE.

PLATE LVI.

"NIAGARA GAS SPRAYER" AND OUTFIT FOR SPRAYING STREET TREES. (After Smith, Rep. N. J. Expt. Sta., 1905.)





a.—Larvae feeding upon bean. Natural size.

b.—Larvae and pupa. More than twice natural size.

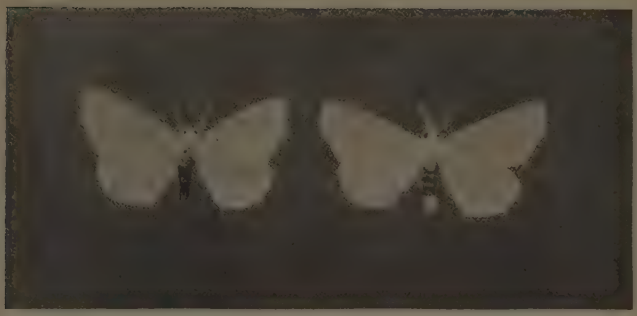
c.—Adult moths. Twice natural size.

GREEN CLOVER WORM.

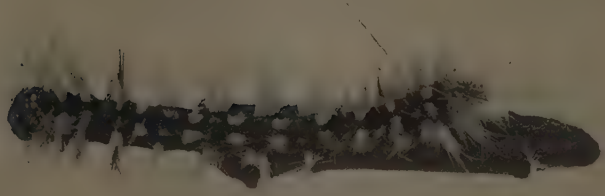
a.—Applying lead arsenate to potatoes.

b.—Outfit for making soluble oil.

SPRAYING POTATOES: OUTFIT FOR MAKING SOLUBLE OIL.



a.—Snow-white Linden moth. Natural size.



b.—Hickory tussock caterpillar killed by a fungus. Twice natural size.

c.—New York weevil. Twice natural size.

LINDEN MOTH: PARASITIZED CATERPILLAR: NEW YORK WEEVIL.

INDEX.

PAGE.

Acetylene 798
Aleyrodes vaporariorum 806, 815
Alsophila pometaria 783, 795
Anasa tristis 805, 811
Ancylus nubeculana 847
Anisopteryx pometaria 778
Anopheles 800, 801, 802, 804
Anthonomus signatus 846
Aphis gossypii 805, 813
" Melon 805, 813
" Squash 805, 814
Apple Leaf-folder 847
" Leaf-miner 768
Assassin Bug 822
Banding trees 792–794
Cabbage Butterfly 768
" Maggot, Treatment to prevent 832–837
Calosoma calidum 786
" *scrutator* 786
Canker Worm 769, 777–796
" " Description 782
" " " Fall 783
" " " Spring 782
" " Natural enemies 786
" " Postal card bulletin on 767
" " Remedies 787–792
" " Summary 794
Carbon disulphide 797
" tetrachloride 798
Chestnut trees injured by beetles 845
Chrysopa sp. 822
Clover Worm, green 769, 828
" " Description 830
" " Remedies 832
Collection, Insect 766
Corn Ear-worm or Boll-worm 847
Correspondence 765
Cucumber Beetle, striped 805, 807
Cucurbits, Insects attacking 805
Culex 800, 801, 802, 804

PAGE.

Currant Worm 768
Diabrotica xii-punctata 805, 809
" *vittata* 805, 807
Elm Leaf Beetle 767, 769, 815–828
" " " Description 818
" " " Natural enemies 821
" " " Remedies 823
" " " Outfit for Spraying 825
" " " Summary 827
Ennomos subsignarius 842
Entomological Features of 1908 768
Epilachna borealis 805, 810
Equipment 766
Eriophyes pyri 770
Estigmene acraea 843
Eumenes fraternus 786
Euvanessa antiopa 768
Expenditures 763
Field Organization 765
Fumigating Nursery Stock for San José scale 796
Galerucella luteola 815
Golden-rod devoured by beetles 844
Gypsy Moth in Connecticut 767
" " Infested localities near Connecticut 776
" " Present condition at Stonington 776
" " Scouting for egg-masses—Eastern Connecticut 774
" " " " " Hartford 774
" " " " " New Haven to Hartford 775
" " " " " Stonington 773
" " Suppression work 772–777
" " " " Funds 776
" " Summary 777
Halisidota caryae 843
" *tessellaris* 843
Heliothis obsoleta 847
Heterocampa guttivitta 848
Hickory Tussock Caterpillar 842
Ichneumon utilis 786
Insect Notes 842
Inspection, Nursery 765, 770
Ithycerus noveboracensis 845
Lead arsenate 767, 823
" " vs. Paris green 843
Lebia grandis 844
Lectures 765
Lema trilineata 844
Leopard Moth 847

PAGE.
Leptinotarsa decemlineata 768
Lime and Sulphur Washes, various kinds 840
Melittia satyriniformis 805, 806
Microgaster 786
Microrophala vittata 844
Mites 770
Monophadnoides rubi 846
Mosquito Work, Beaver Swamp 802
" " East Haven Rifle Range 800
" " Stamford 804
Nectarophora cucurbitae 805, 814
Nodonota puncticollis 845
Nothrus ovivorus 786
Nursery Firms receiving certificates in 1908 771
Office Force 765
Ogdoconta cinereola 828
Otiorynchus sulcatus 846
Paleacrita vernata 782, 794
Pamphilius persicum 767
Paris green 767, 824
Peach Sawfly 767
Pear injured by weevil 845
Pear Leaf Mite 770
Pegomyia brassicae 832
Plant lice 770
Plathypena scabra 769, 828
Platygaster 786
Platynus punctiformis 822
Podisus maculiventris (*spinosus*) 769, 822
Pontia rapae 768
Potato Beetle 768
Potter Wasp 786
Praying Mantis 822
Pteronus ribesii 768
Pterostichus lucublandus 844
Publications 767
Pyramidal Caterpillar 848
Pyrophila pyramidoides 848
Quedius molochinus 822
Receipts 763
Reduvius novenarius 822
San José Scale 768
Sawfly, Peach 767
" Raspberry 846
Snow-white Linden Moth 842
Soldier Bug, Spined 769, 822
Soluble Oils, Home-made 837
" " Various kinds 840

PAGE.
Southern Corn Root-worm 805, 809
Spiny Elm Caterpillar 768
Sporotrichum globuliferum (*entomophilum*) 821
Squash Aphis 805, 814
" Borer 805, 806
" Bug 805, 811
" Lady-beetle 805, 810
Stagmomantis carolina 822
Tarred paper disks 835, 836
Tetranychus bicolor 770
Tetrastichus xanthomelaenae 821
Three-Lined Leaf Beetle 844
Tischeria malifoliella 768
Trirhabda canadensis 844
Weevil, New York 845
" Strawberry 846
White Fly, Greenhouse 806, 815
Zeuzera pyrina 847